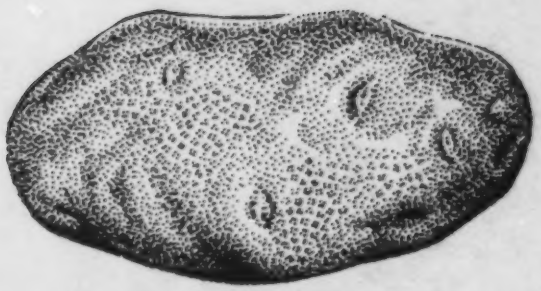
VOL. 4



1991

TECHNICAL REPORTS ON POTATOES
RAPPORTS TECHNIQUES SUR LES POMMES DE TERRE

POTATO INDUSTRY COORDINATING COMMITTEE
COMITÉ DE COORDINATION DE L'INDUSTRIE DE LA POMME DE TERRE
NEW BRUNSWICK DEPARTMENT OF AGRICULTURE
MINISTÈRE DE L'AGRICULTURE DU NOUVEAU BRUNSWICK

VOL. 4

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Robert W. Saintonge
Deputy Minister
Sous-Ministre

Gérald H. Clavette
Minister of Agriculture
Ministre de l'Agriculture

92-07536/

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FOREWORD

This is the fourth annual publication of the Technical Reports on Potatoes.

The purpose of the Reports is to provide farmers and agricultural specialists a summary of the major applied research and demonstration projects on potato production conducted by members of the Potato Industry Co-ordinating Committee during the past year.

My sincere gratitude to the specialists who conducted these projects and submitted reports and to the potato growers who provided farm land, machinery and other assistance.

The financial contributions of the Canada-New Brunswick Cooperation Agreement on Agri-Food Development are acknowledged in supporting many of the projects.

My thanks also to Guy Bernard, editor of this publication.

Clair Gartley, Chairman
Potato Industry Co-ordinating Committee

PRÉFACE

Voici la quatrième publication annuelle des rapports techniques sur les pommes de terre.

Le but de ces rapports est de fournir aux agriculteurs, agricultrices et aux spécialistes en agriculture, un sommaire des projets majeurs de recherche et de démonstration sur la production des pommes de terre. Ces projets ont été effectués au cours de l'année dernière par les membres du comité de coordination de l'industrie de la pomme de terre.

Mes sincères remerciements aux spécialistes en charge des projets qui ont soumis ces rapports et aux producteurs qui ont fourni leur aide et qui ont mis leur terre et leur machinerie à notre disposition.

Je veux également souligner la contribution financière accordée pour un grand nombre de ces projets en vertu de l'Entente auxiliaire Canada/Nouveau-Brunswick sur le développement du secteur agro-alimentaire.

Mes remerciements également à Guy Bernard, éditeur de cette publication.

Clair Gartley, Président
Comité de coordination de l'industrie de la pomme de terre

THE 1991 GROWING SEASON

George Read and Marc Robichaud

ABSTRACT: The 1991 Growing season was characterized by a very dry June and July followed by a wet harvest period, this was much the same pattern as was experienced in 1990. Heat units were above normal for the season. Sunshine hours were above normal for the season.

LA SAISON DE CROISSANCE 1991

RÉSUMÉ: La saison de croissance 1991 s'est caractérisée par une période très sèche durant les mois de juin et juillet suivie d'une période de récolte pluvieuse. Des caractéristiques semblables ont été observées en 1990. Les unités thermiques ainsi que l'insolation effective ont été au-dessus de la normale pour cette saison.

INTRODUCTION: Generalizing the weather conditions for the province for an entire season does not explain crop performance on individual farms or even separate regions for the most part. The climate of farms varies significantly from one location to another with such things as frost occurrence, crop development, planting, insect and disease development or harvesting operations. It is therefore necessary to evaluate specific varieties, recommendations and production practices with the most localized or representative information as possible.

Despite these farm scale influences, the overall performance of crops on a provincial scale can often be correlated with major deviations from normal growing season conditions, such as droughts, wet periods, extensive frosts or unusually warm or cold seasons. With these factors recognized, a general summary of the 1991 cropping season weather is presented.

SUMMARY:

May: The month was wet for all areas of the province except the extreme southwest which was approximately 70% of normal rainfall. Heat units were much greater than average ranging from near normal in Woodstock to 200% of normal in Charlo. Most of the province was about ten percent above normal in hours of bright sunshine.

June: The month was dry, very similar to June of 1990. Temperatures were slightly above normal throughout most of the province. Total rainfall for the month varied from 17% of normal in Saint John to 132% of normal in Bathurst. Bathurst however received most of their rain in one large event. This type of distribution is typical of thunderstorm activity that occurs in summer and the quick downpours often lead to excessive runoff and little benefit to dry fields. The sunshine for the month was 25% above normal with an extra 50 hours.

July: This month presented drought conditions when combined with June's low rainfall. As the map for percent of normal precipitation for June indicates, the totals were generally less than half of normal. Temperatures were from near normal to 123% of normal. Sunshine hours were generally at or above normal for this time of year.

August: The rainfall for the month was very high ranging from 119% to 232 % of normal. Temperatures continued to be near or moderately above normal. Sunshine hours were near normal.

September: The month continued the wet conditions of the previous month making Harvest operations difficult. The poor distribution of water throughout the growing season was reflected in problems for several crops. Temperatures were above normal for September and the total growing degree days for the season were approximately 5 to 10% above the long term average.

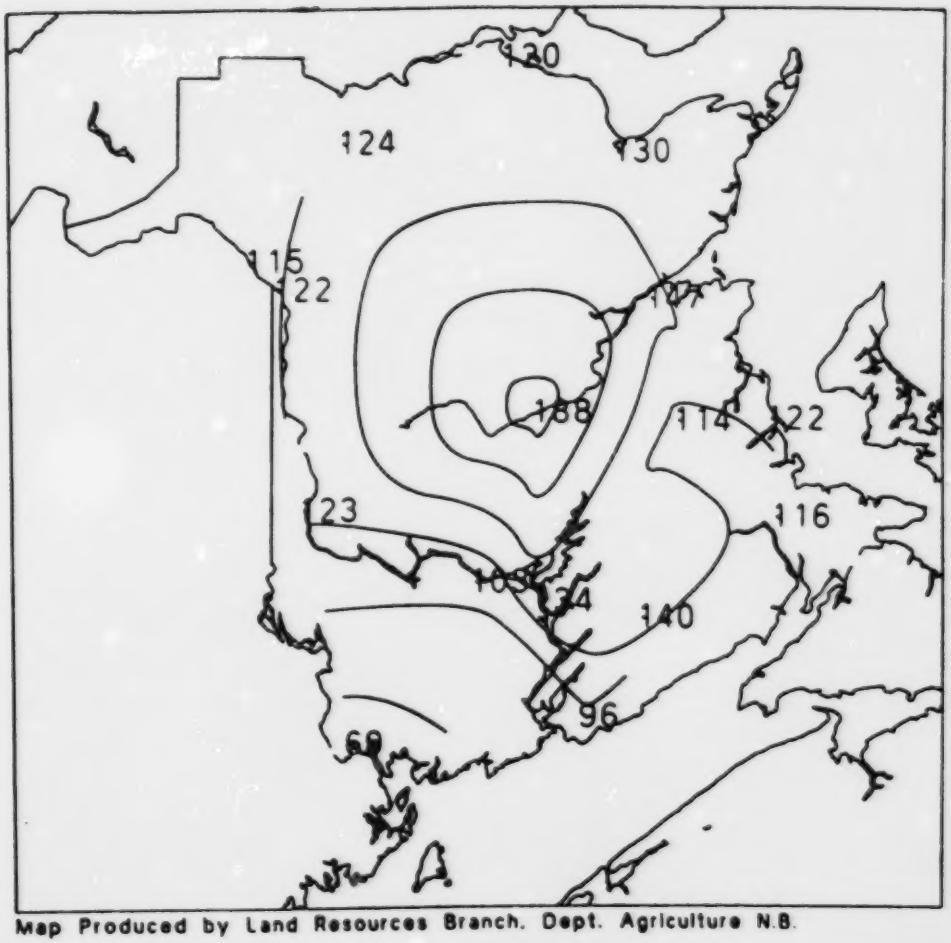
The month of October was wet resulting in poor harvesting conditions for potatoes.

MAPS: The following maps, were prepared by the New Brunswick Department of Agriculture using point data courtesy of Environment Canada. Precipitation and growing degree days maps (GDD) as a percent of normal are presented for the months May, June, July, August, and September. Graphs of weekly rainfall and monthly sunshine hours are given for selected sites. Days of measurable precipitation are also included. The results are based on unverified reports which will be quality controlled at a later date.

ACKNOWLEDGEMENTS: The authors would like to thank Graham Rankine for his assistance in mapping the climate parameters using a digital terrain model.

FIGURE 1:

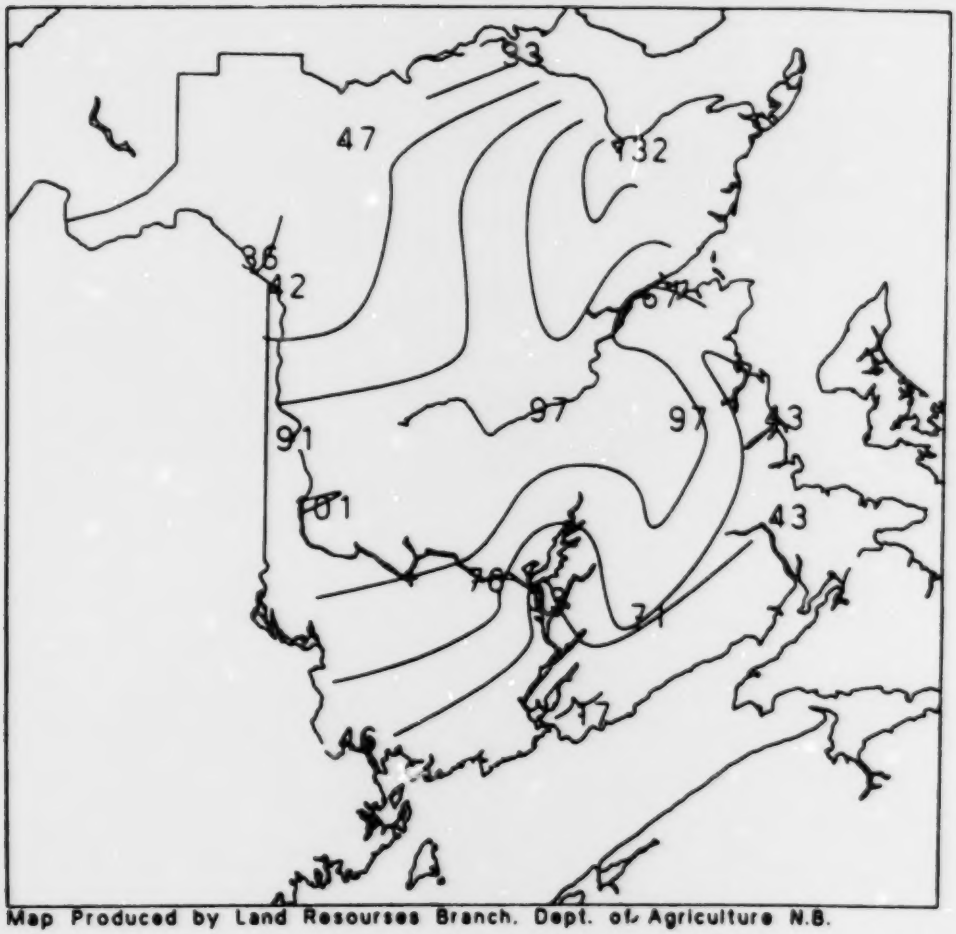
PERCENT OF NORMAL PRECIPITATION
MAY 1991



Map Produced by Land Resources Branch. Dept. Agriculture N.B.

FIGURE 2:

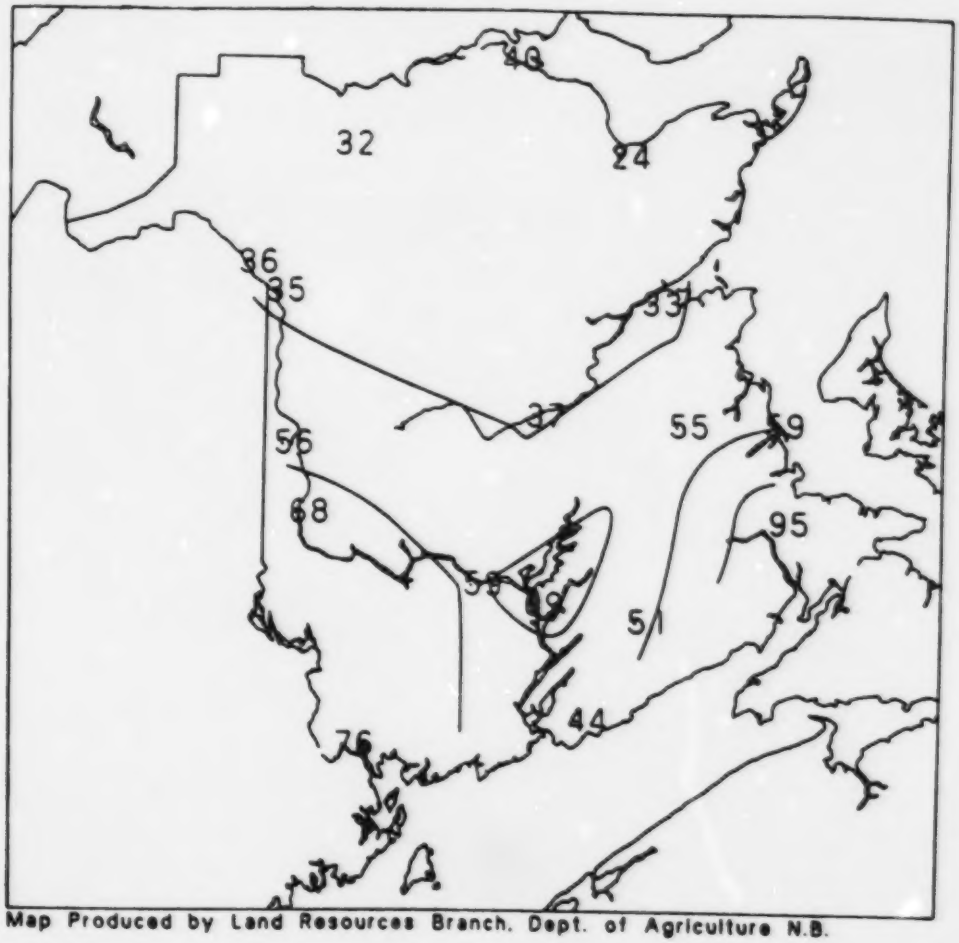
PERCENT OF NORMAL PRECIPITATION
JUNE 1991



Map Produced by Land Resourses Branch. Dept. of Agriculture N.B.

FIGURE 3:

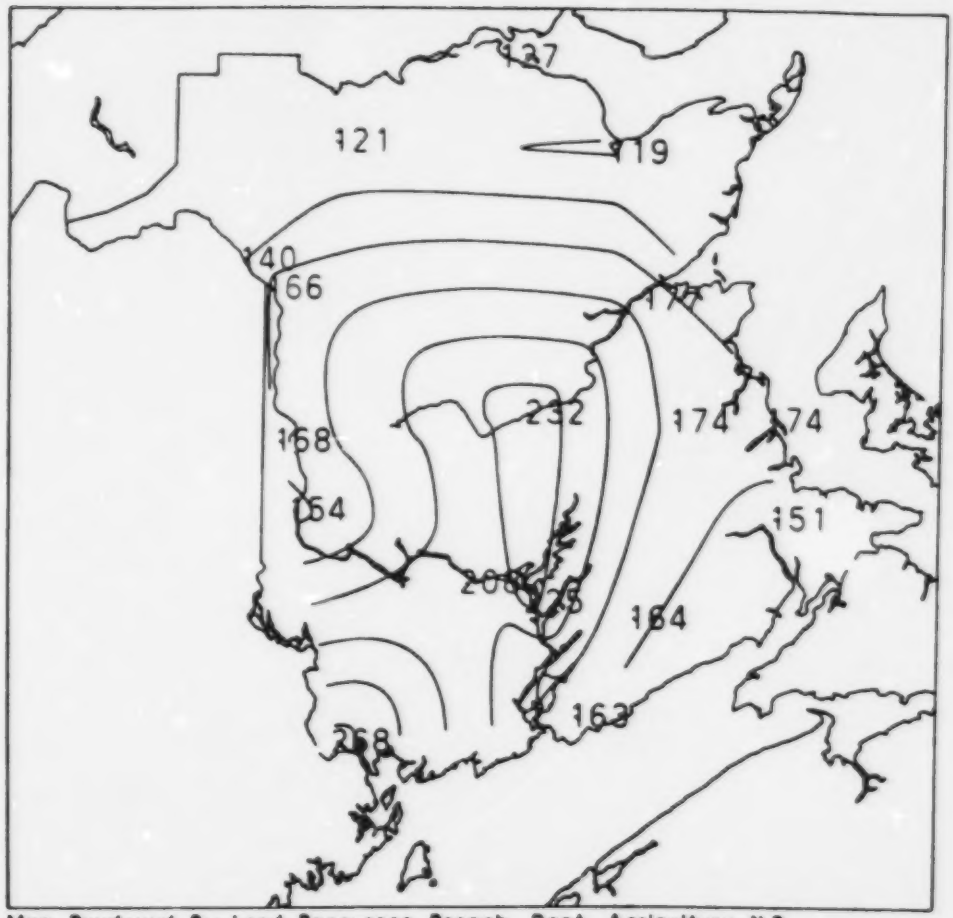
PERCENT OF NORMAL PRECIPITATION JULY 1991



Map Produced by Land Resources Branch, Dept. of Agriculture N.B.

FIGURE 4:

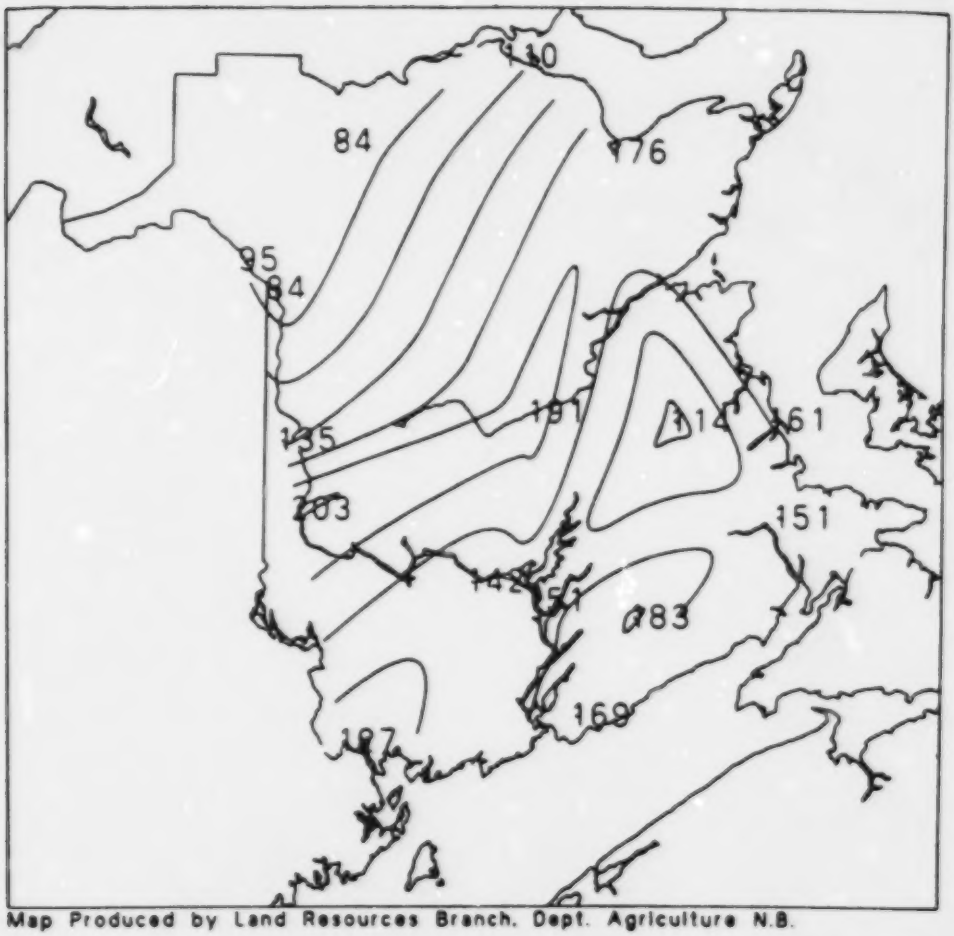
PERCENT OF NORMAL PRECIPITATION AUGUST 1991



Map Produced By Land Resources Branch, Dept. Agriculture N.B.

FIGURE 5:

PERCENT OF NORMAL PRECIPITATION SEPTEMBER 1991

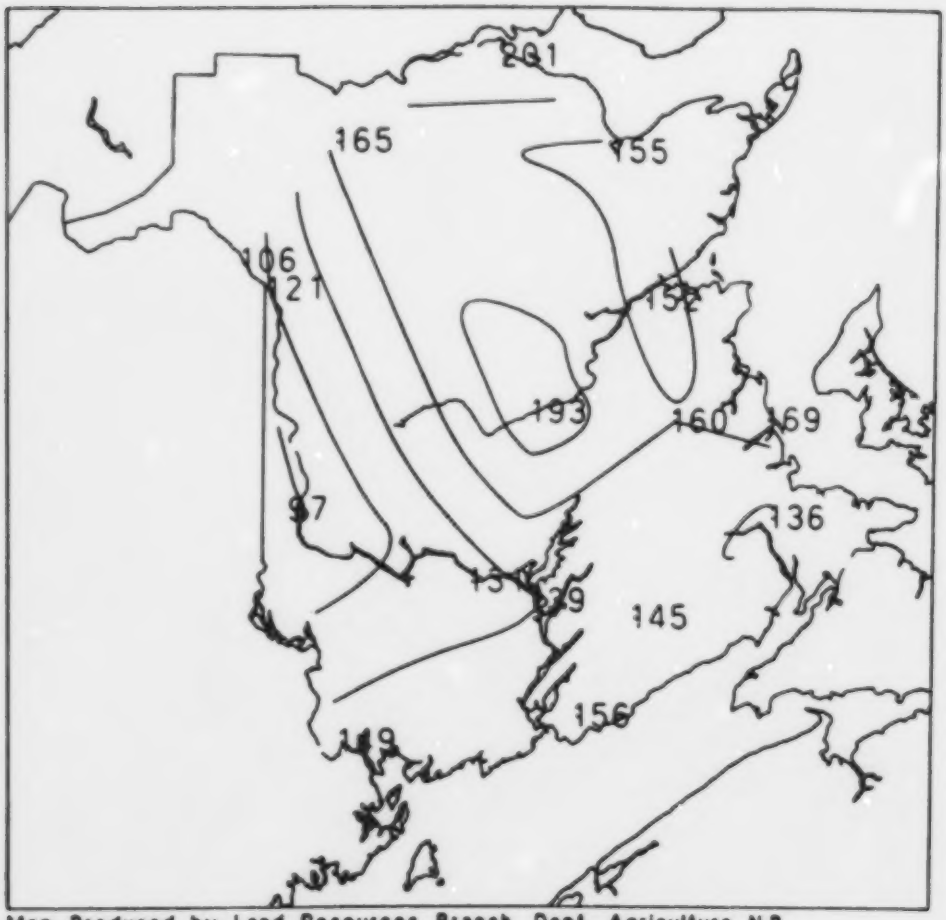


Map Produced by Land Resources Branch, Dept. Agriculture N.B.

FIGURE 6:

PERCENT OF NORMAL GDD > 5 DEGREES C. (FROM MAY 1, 1991)

MAY 1991

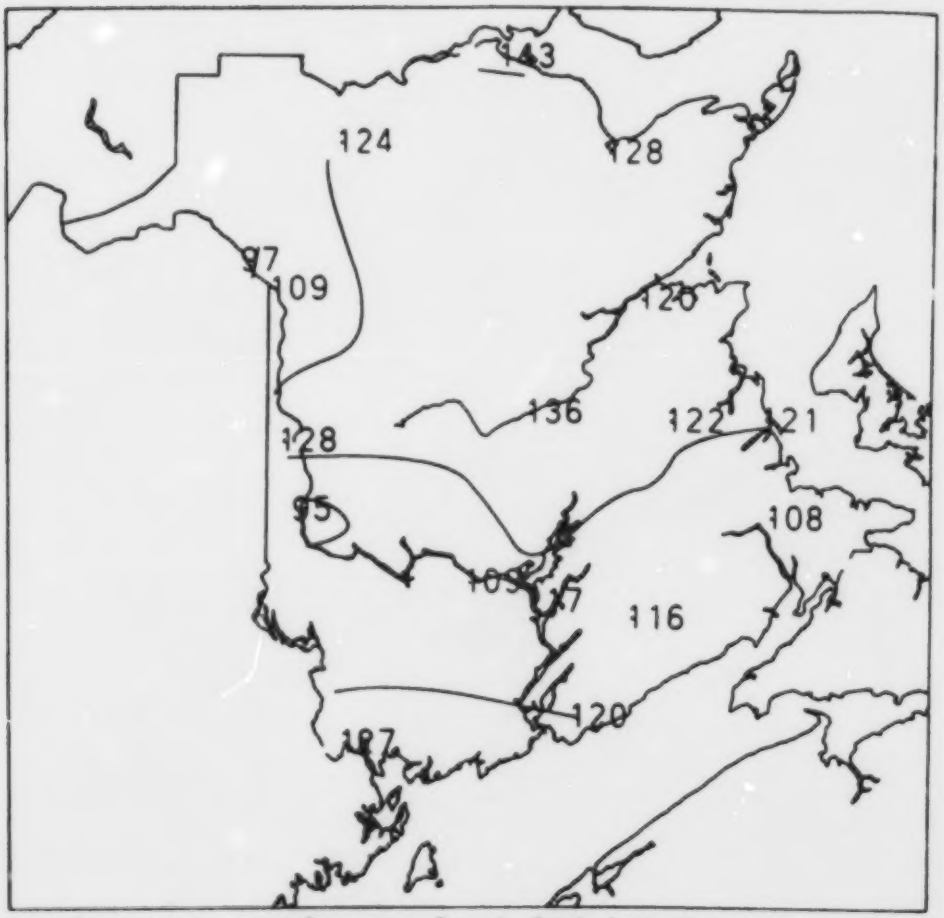


Map Produced by Land Resources Branch, Dept. Agriculture N.B.

FIGURE 7:

PERCENT OF NORMAL GDD > 5 DEGREES C. (FROM MAY 1, 1991)

JUNE 1991

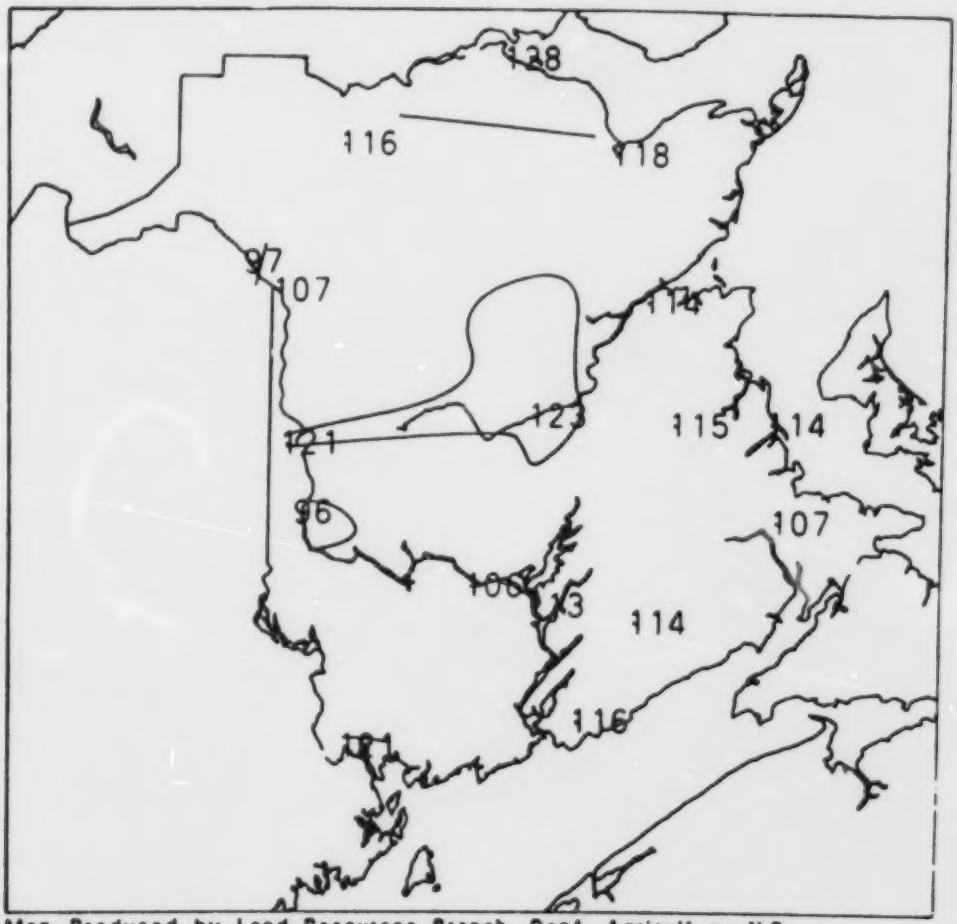


Map Produced by Land Resources Branch, Dept. Agriculture N.B.

FIGURE 8:

PERCENT OF NORMAL GDD > 5 DEGREES C. (FROM MAY 1, 1991)

JULY 1991

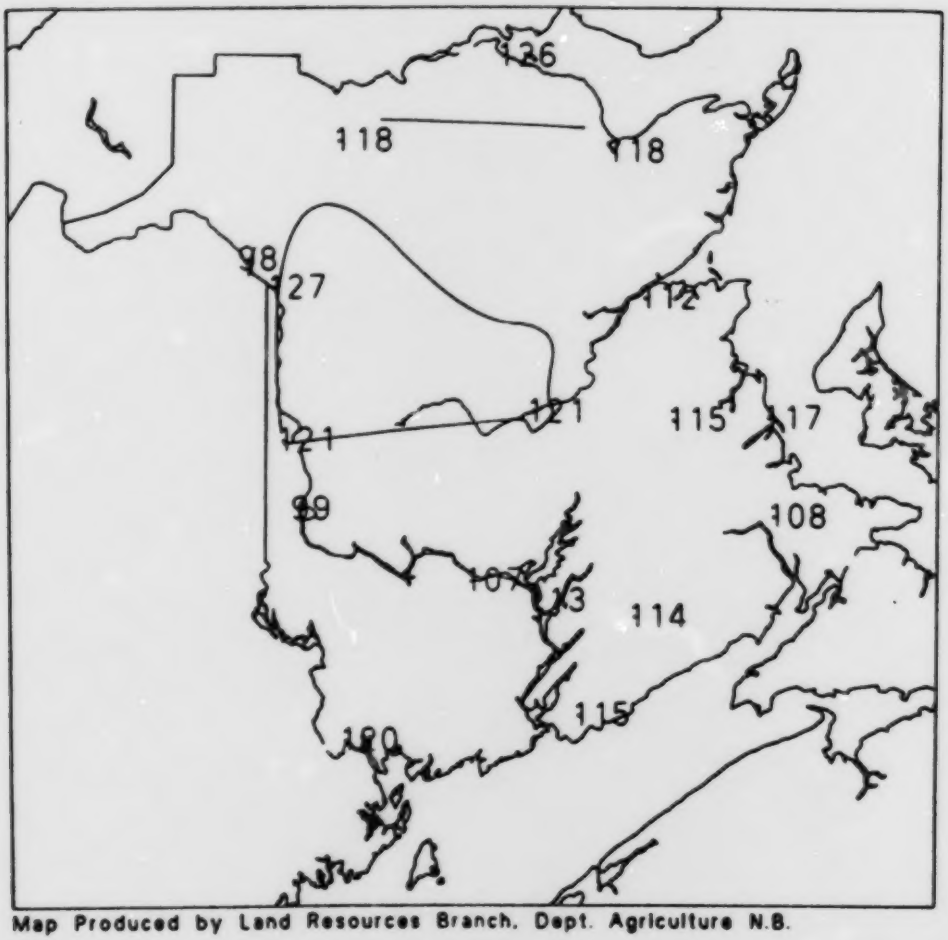


Map Produced by Land Resources Branch, Dept. Agriculture N.B.

FIGURE 9:

PERCENT OF NORMAL GDD > 5 DEGREES C. (FROM MAY 1, 1991)

AUGUST 1991

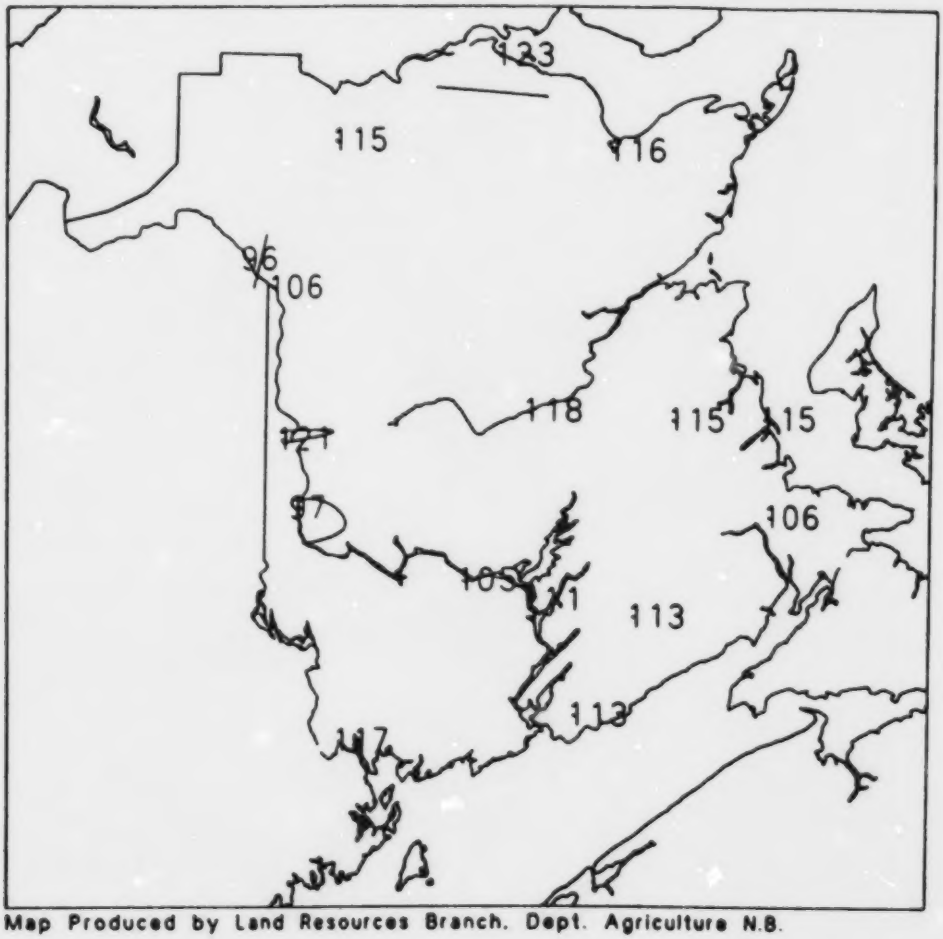


Map Produced by Land Resources Branch, Dept. Agriculture N.B.

FIGURE 10:

PERCENT OF NORMAL GDD > 5 DEGREES C. (FROM MAY 1, 1991)

SEPTEMBER 1991



Map Produced by Land Resources Branch. Dept. Agriculture N.B.

BATHURST - PRECIPITATION CHART

for Growing Season

(1991 data compared to normal)

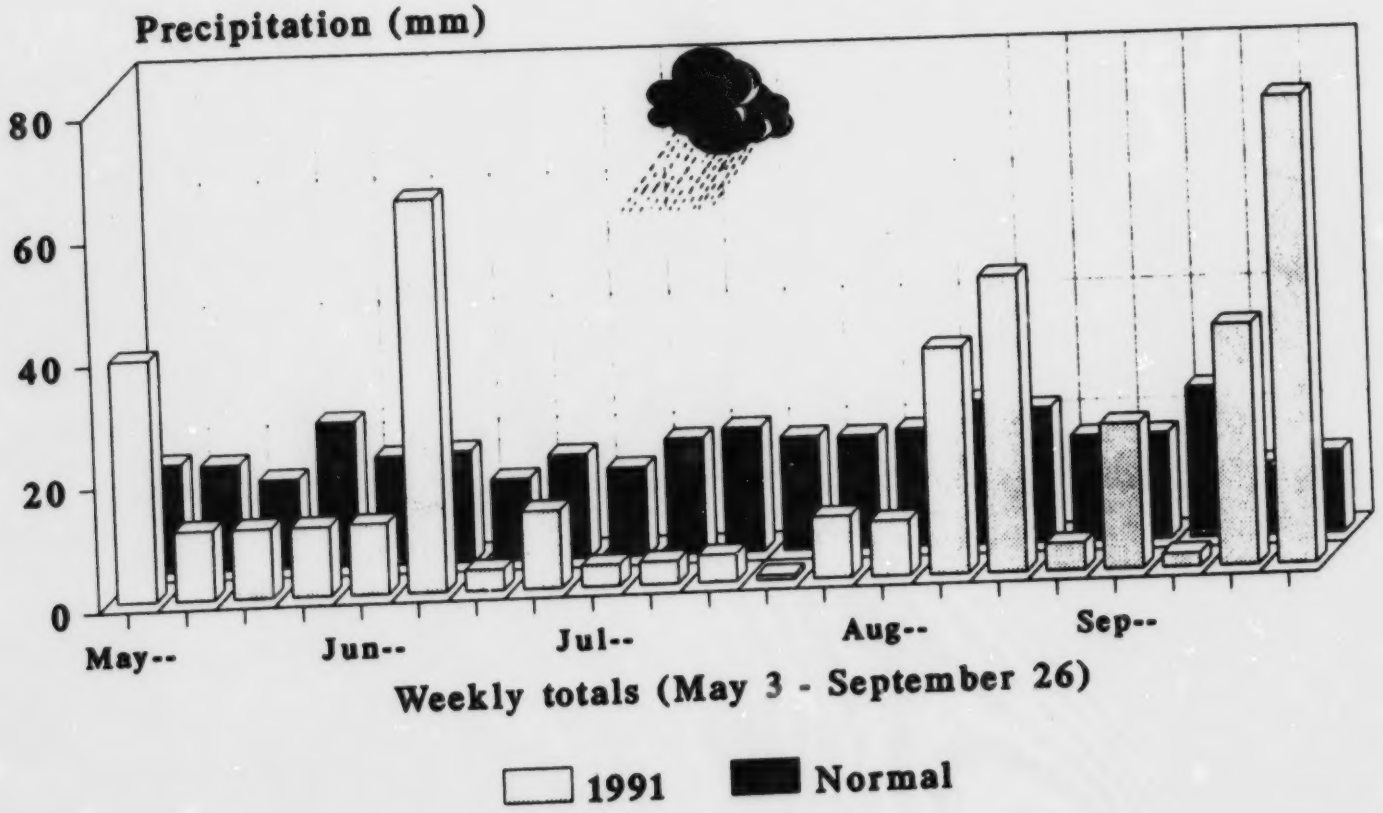


CHART PRODUCED BY LAND RESOURCES BRANCH,
N.B. DEPARTMENT OF AGRICULTURE

CHATHAM - PRECIPITATION CHART

for Growing Season

(1991 data compared to normal)

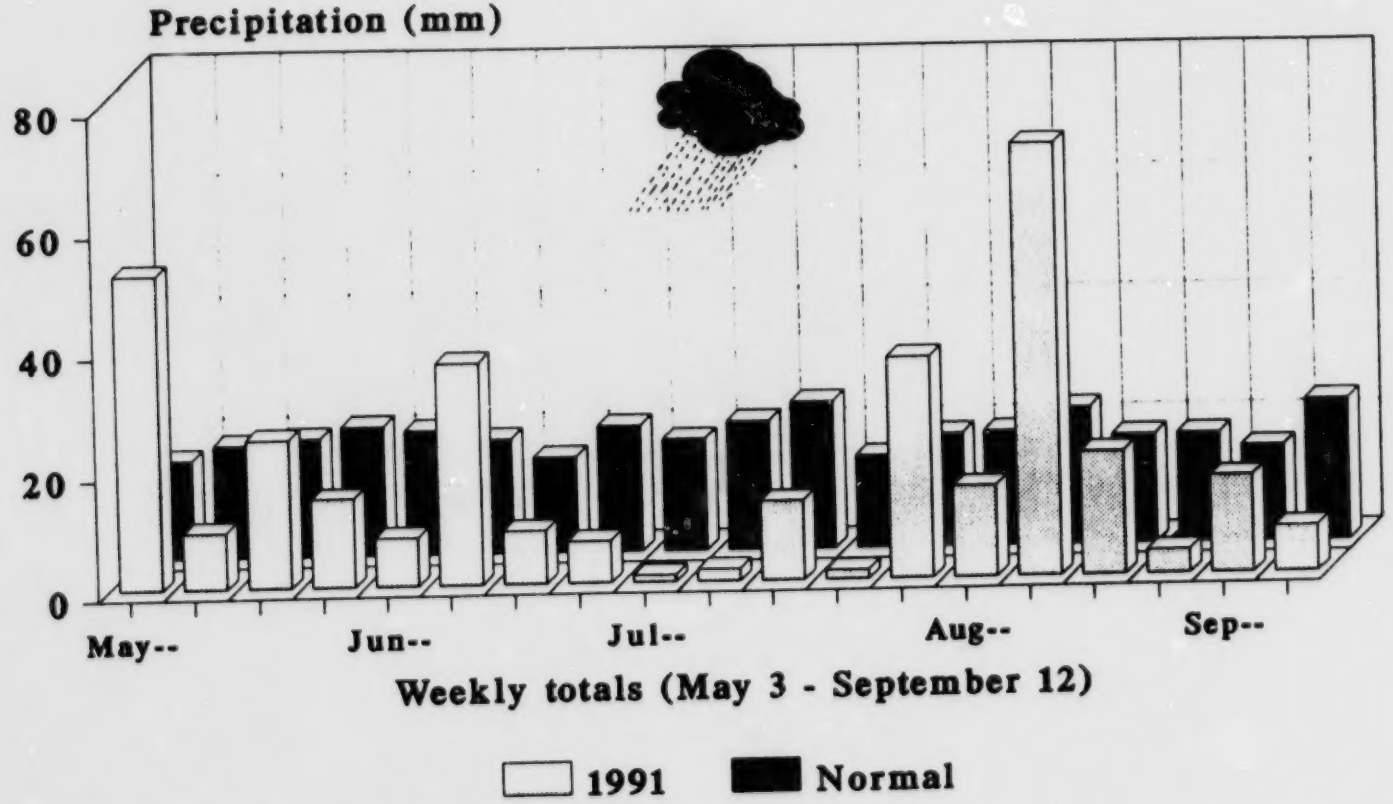


CHART PRODUCED BY LAND RESOURCES BRANCH,
N.B. DEPARTMENT OF AGRICULTURE

GRAND FALLS - PRECIPITATION CHART

for Growing Season

(1991 data compared to normal)

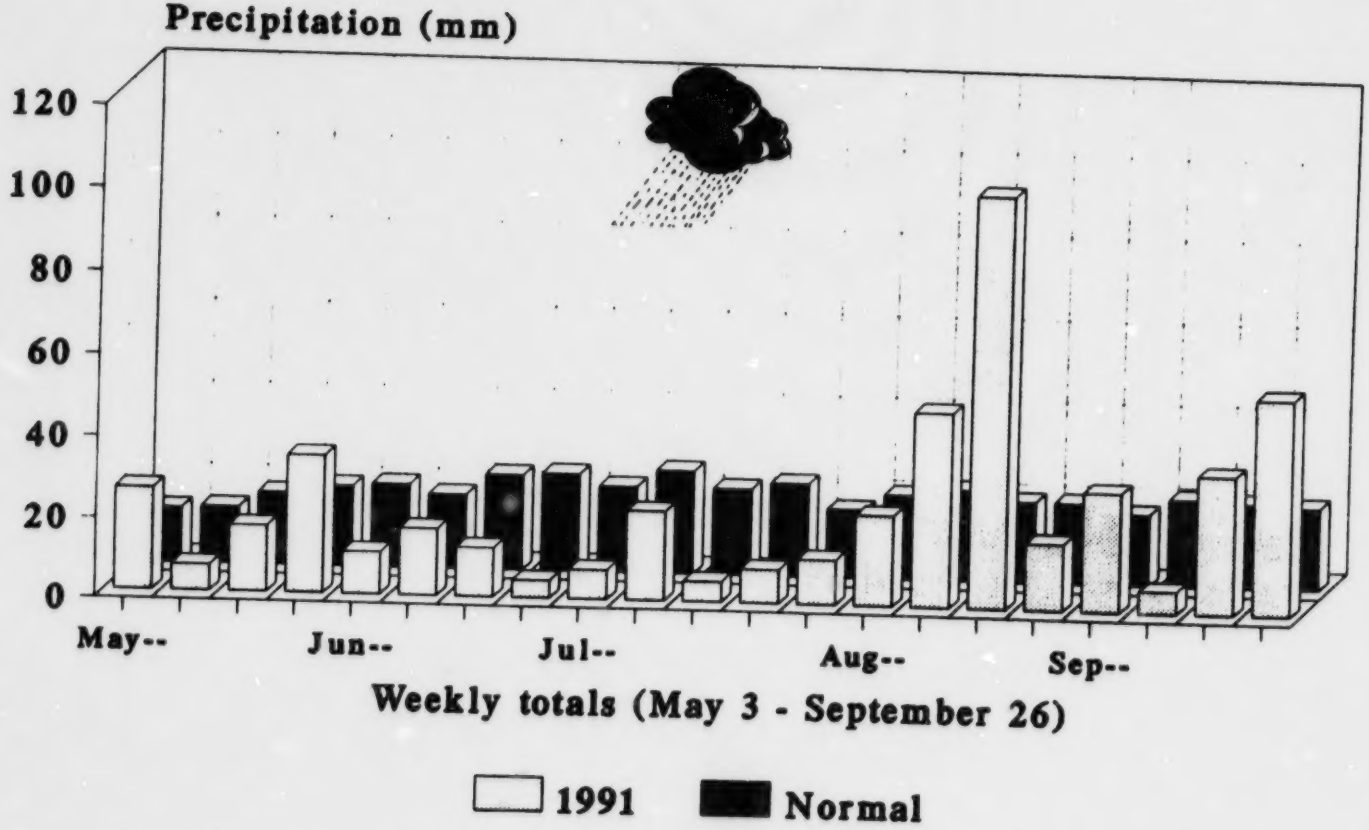


CHART PRODUCED BY LAND RESOURCES BRANCH,
N.B. DEPARTMENT OF AGRICULTURE

SUSSEX - PRECIPITATION CHART

for Growing Season

(1991 data compared to normal)

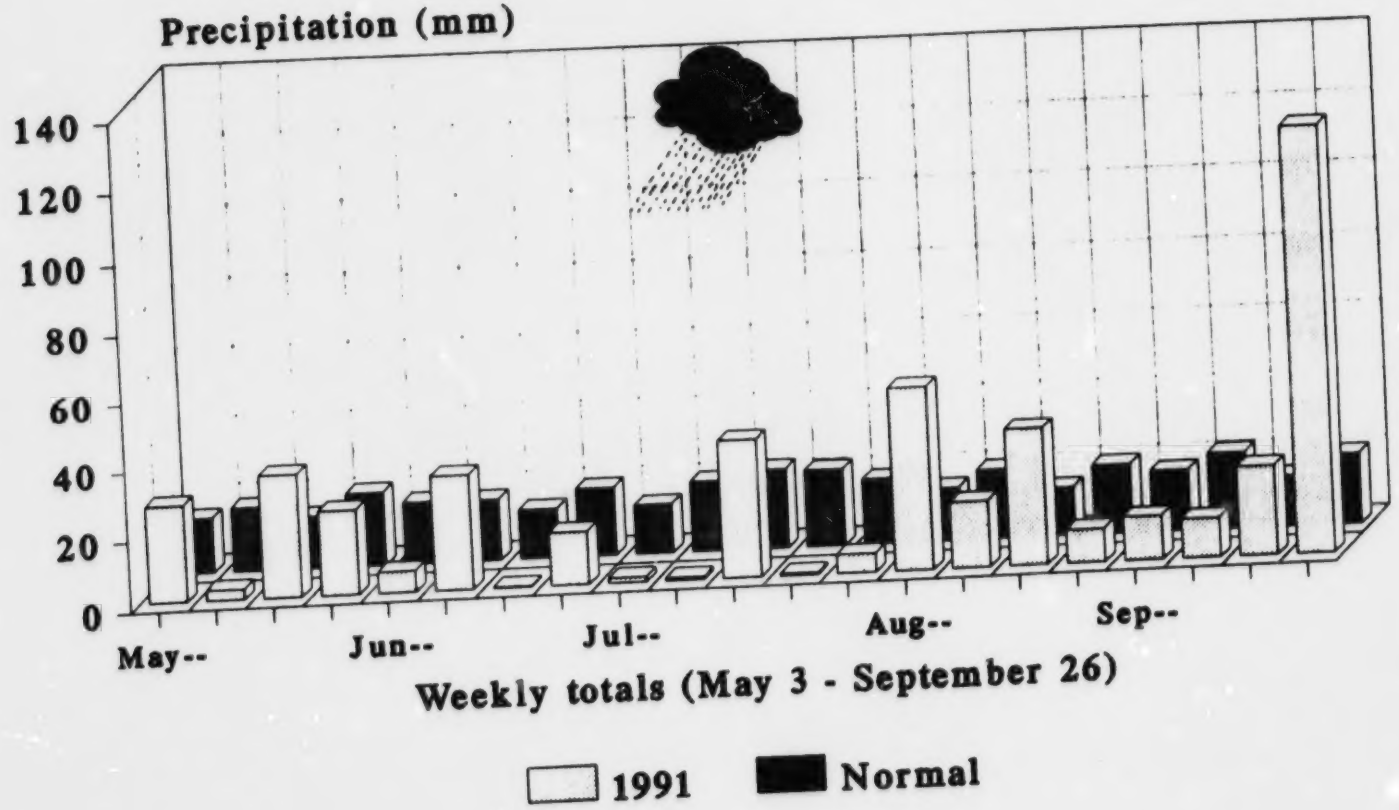


CHART PRODUCED BY LAND RESOURCES BRANCH,
N.B. DEPARTMENT OF AGRICULTURE

CHARLO (A) - SUNSHINE HOURS
for Growing Season
(1991 data compared to normal)

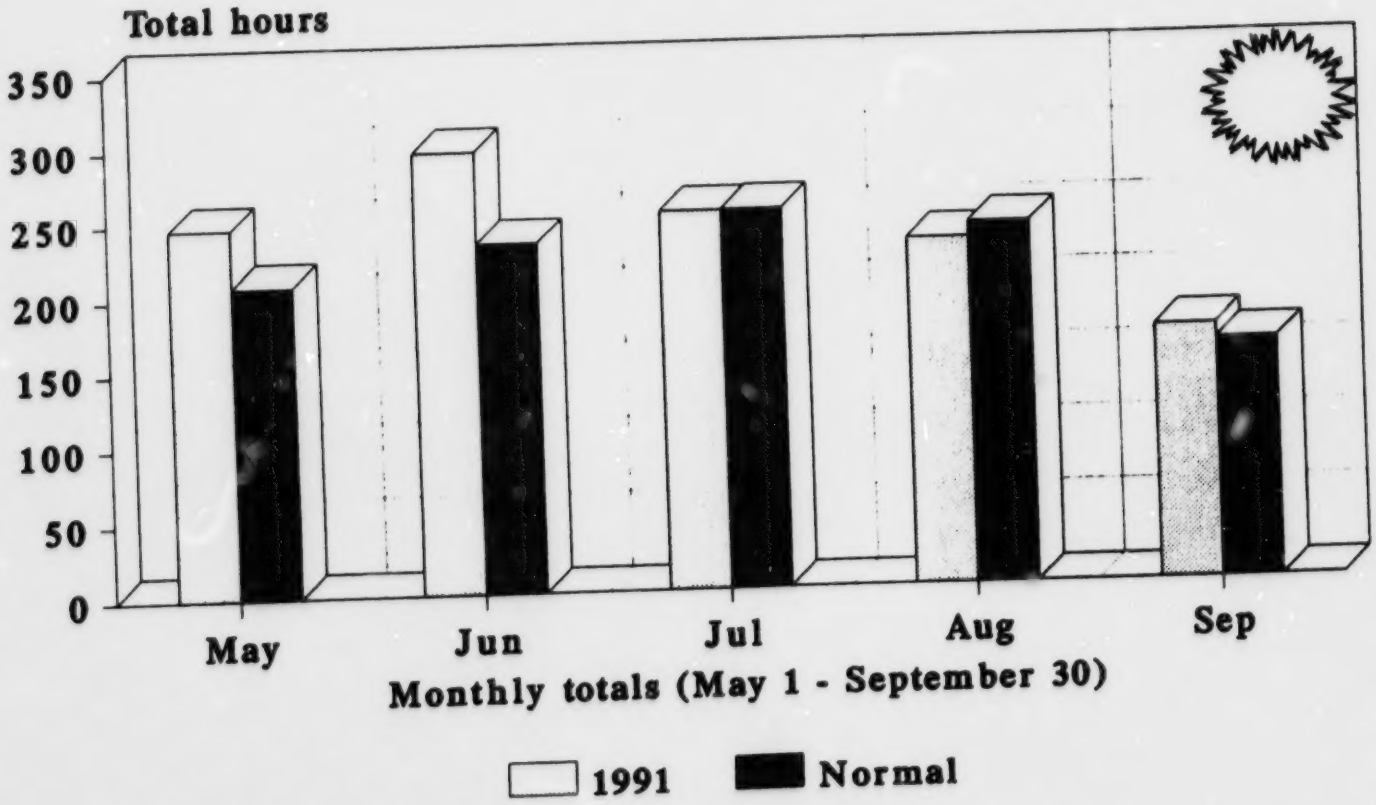


CHART PRODUCED BY LAND RESOURCES BRANCH,
N.B. DEPARTMENT OF AGRICULTURE

MONCTON (A) - SUNSHINE HOURS

for Growing Season

(1991 data compared to normal)

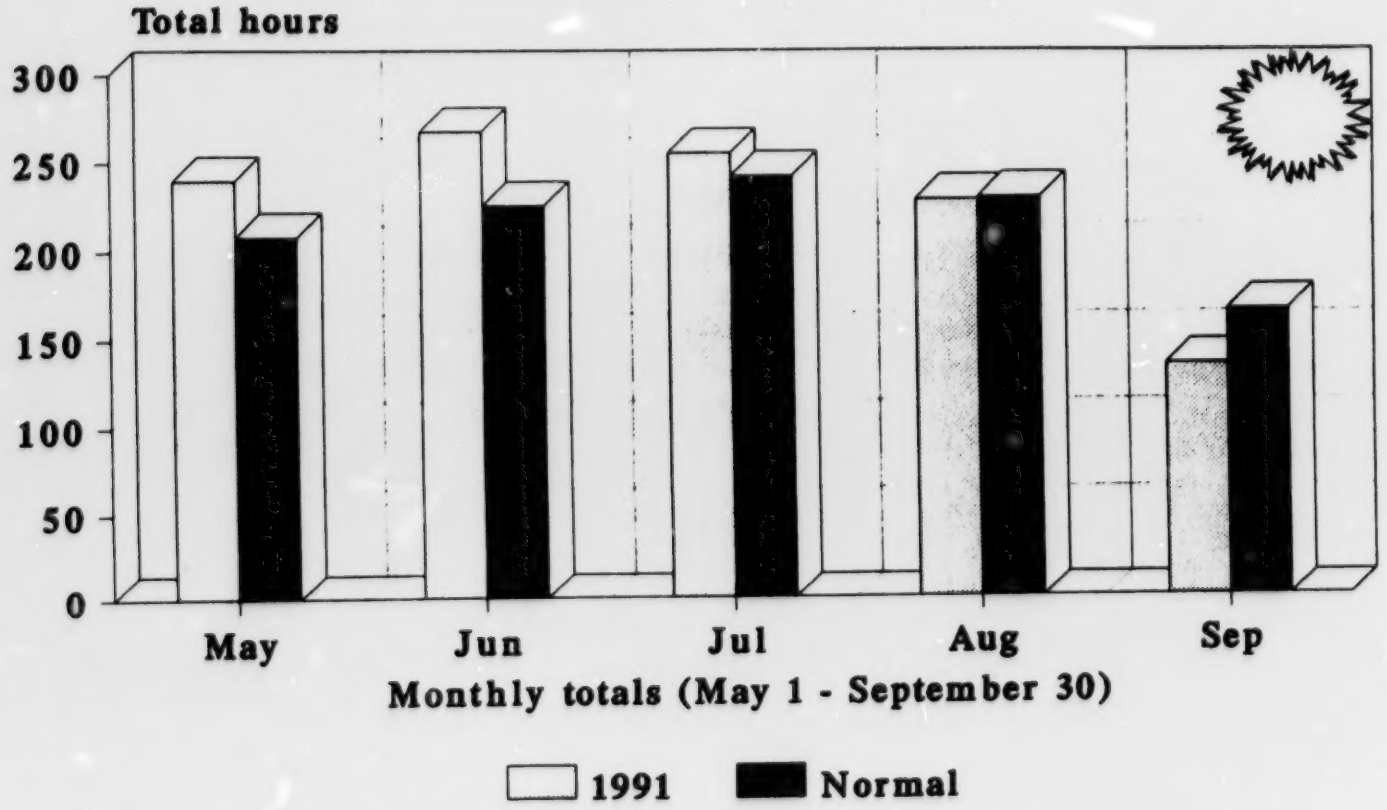


CHART PRODUCED BY LAND RESOURCES BRANCH,
N.B. DEPARTMENT OF AGRICULTURE

NUMBER OF DAYS WITH MEASURABLE RAINFALL

LOCATION	MAY		JUNE		JULY		AUGUST		SEPTEMBER	
	NORMAL	1991	NORMAL	1991	NORMAL	1991	NORMAL	1991	NORMAL	1991
WOODSTOCK	9	10*	11	5	11	10	11	7*	10	7
GRAND FALLS	12	14	12	9	14	9	13	16	12	10
BATHURST	12	15	12	12	13	7	12	19	11	10
SUSSEX	9	11	9	10	8	6	7	15	7	12
BOUCTOUCHE	13	16	13	8*	11	14*	11	15*	10	9*
SAINT JOHN	13	10*	14	9	12	8	12	15	12	12

* MISSING DATA

INSPECTION OF GREENHOUSES FOR THE PRESENCE OF POTATO INFESTING APHIDS IN 1991

INSPECTION DES SERRES EN 1991 POUR LA PRÉSENCE DE PUCERONS INFESTANT LES POMMES DE TERRE

GUY BERNARD

ABSTRACT:

Green peach aphids were frequently found in greenhouses inspected during the spring of 1991. Greenhouses thus continue to provide local sources of aphids which can contribute to the spread of viral diseases in seed potato crops.

RÉSUMÉ:

Des pucerons verts du pêcher furent fréquemment détectés dans les serres au printemps de 1991. Les serres continuent donc à être un réservoir local de puçerons pouvant contribuer à la dissémination de maladies virales dans les récoltes de pommes de terre de semence.

Many species of aphids can play a role as vectors of virus diseases. The green peach aphid, in particular, is the principal vector of PLRV (Leafroll) and an efficient vector of PVY (Mosaic) to potatoes. Both diseases can cause yield reductions if seed tubers are affected. In addition, plants of susceptible varieties infected with PLRV will often develop a tuber disorder, known as net necrosis, which greatly affects the quality of table and processing potatoes.

These two diseases, leafroll and mosaic, account for a substantial proportion of seed field rejections each year in New Brunswick. Since the tolerance for virus diseases in seed crops is low, seed growers are acutely aware of the potential for disease transmission from aphids alighting in their fields.

The green peach aphid overwinters on peach trees in southern locations. Closer to us, in the State of Maine, it often overwinters on the Canada plum in the form of eggs. In New Brunswick however, the green peach aphid does not ordinarily overwinter on the Canada plum but it can survive the winter in greenhouses. It can also be brought in on transplants imported from other regions.

In a survey of 29 greenhouses, conducted in the potato belt of New Brunswick on May 30th and May 31st, 1991, 58% were found to be infested with sometimes large quantities of green peach aphids. Winged forms were present in only one of those greenhouses. Only 41% of the greenhouses were completely free of aphids at the time of inspection. Since plants from these greenhouses are sold and distributed widely throughout potato growing areas, the aphids they harbour can become an early source of infestation in seed fields.

Early infestations of seed fields by aphids can substantially increase in-field virus transmission if inoculum levels are high in the crop.

The results of this survey indicate that local greenhouses still continue to be an important source of green peach aphids which may initiate populations in potato fields and contribute to the spread of viral diseases in the seed crop.

AERIAL MONITORING OF POTATO INFESTING APHIDS IN NEW BRUNSWICK IN 1991

ENQUÊTE SUR LES VOLS DE PUCERONS AYANT INFESTÉ LES POMMES DE TERRE AU NOUVEAU BRUNSWICK EN 1991

GUY BERNARD

ABSTRACT:

Green peach aphid catches in yellow pan traps were moderate during the 1991 season. Relatively small catches were recorded throughout the month of August. Common potato aphid catches were lower than average while buckthorn aphid catches remained relatively high for the third consecutive season. The greatest numbers of buckthorn aphids were caught during the latter part of June.

RÉSUMÉ:

Les captures des pucerons verts du pêcher à l'aide des pièges jaunes furent modérées durant la saison 1991. Des captures relativement faibles eurent lieu durant la plupart des journées du mois d'août. Les captures de pucerons communs de la pomme de terre furent faibles tandis que celles de pucerons du nerprun atteignirent un niveau relativement élevé pour la troisième année consécutive. Les plus grands nombres de pucerons du nerprun furent capturés durant les deux dernières semaines du mois de juin.

Aphids, mainly because of their ability to transmit virus diseases, are an important pest of potatoes. The Green Peach Aphid (Mp), in particular, is the major vector of PLRV (leafroll) and an efficient vector of PVY (mosaic). Both of these diseases account for a substantial proportion of the seed field rejections each year in New Brunswick. Aphid populations have been monitored extensively in the Province since 1974 and a warning service based on aphid catches in yellow pan traps has been available to potato producers ever since.

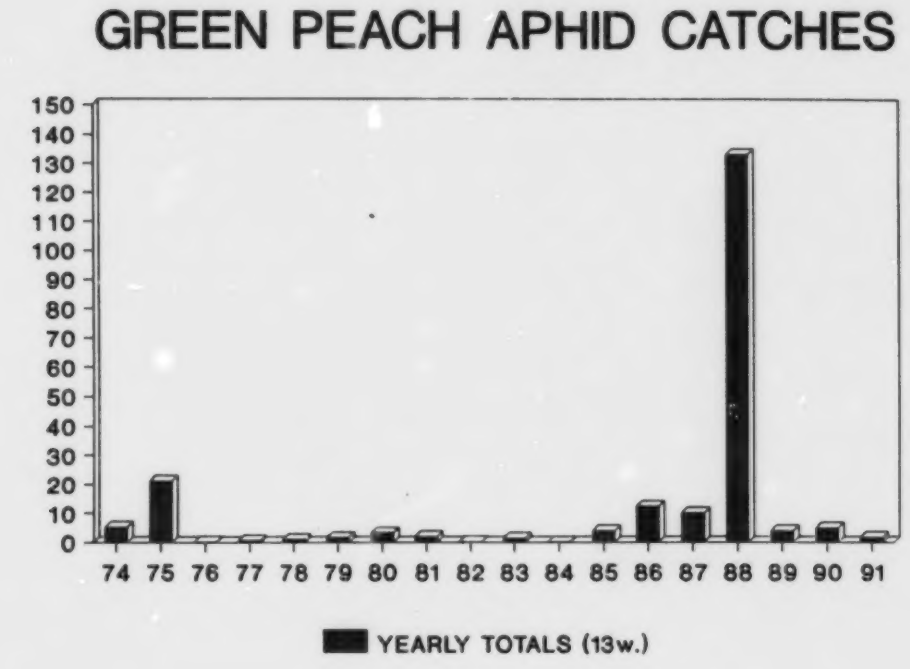
In 1991, 150 yellow pan traps were operated in the province mostly in the counties of Carleton, Victoria and Madawaska. Contents of yellow pan traps are collected by growers in seed fields and by scouts in table and processing potato fields. Samples are brought to the Agricultural Resource Centre in Wicklow for identification. As part of the aphid advisory service, weekly reports on aphid flights, based on these trappings, are sent to cooperating farmers, inspectors and others during the growing season. Information is also made available to all growers through the use of a toll-free telephone answering service, and personal letters to producers.

The practice of setting mandatory topkill dates for seed potato crops, which was established in New Brunswick in 1981, was discontinued during the 1990 season. Since then, potato producers have simply been advised to apply a topkiller to seed crops as soon as possible after the occurrence of significant green peach aphid catches in their region.

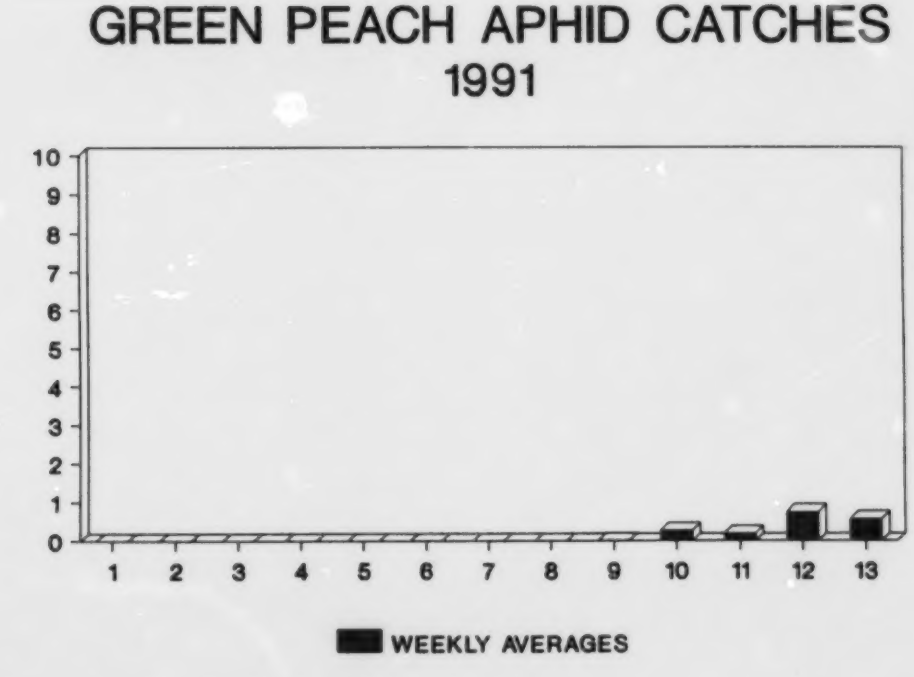
The first catches of green peach aphids for the 1991 season occurred on July 30th near Bloomfield. On August 1, small catches were recorded for several areas including Glassville, Hartland, Jacksontown and Carlingford. The most important single event catches occurred on August 5th in Jacksontown (16); on August 15th in Glassville (10) and Drummond (9); and on August 19th at Bon Accord (11). Overall catches of Green Peach aphids (Mp) in yellow pan traps were moderate during the 1991 season (Graph #1). Average catches over the whole region were highest during the last two weeks of August (Graph #2).

Catches of the buckthorn aphid remained relatively high for the third consecutive season (Graph #3) and occurred throughout most of the summer, but were highest during the latter part of June (Graph #4). Common potato aphid catches were low this season (Graph #5) and occurred throughout the season (Graph #6). Of the latter two aphid species, only the buckthorn aphid is thought to be able to play a significant role in PVY transmission. Catches of other aphid species were higher than average in 1991 (Graph #7) and also occurred throughout the season (Graph #8).

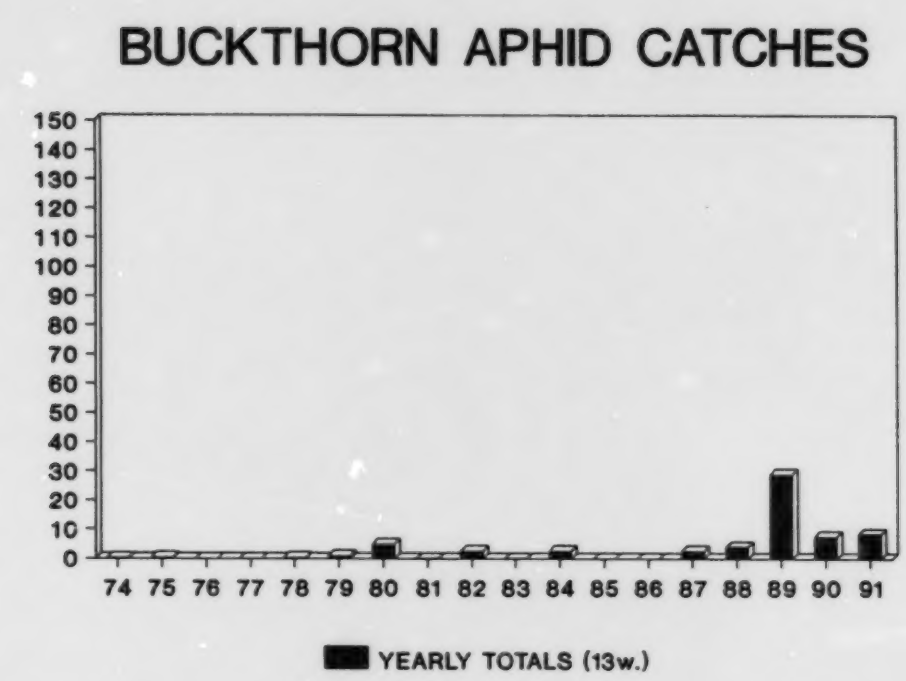
GRAPH #1



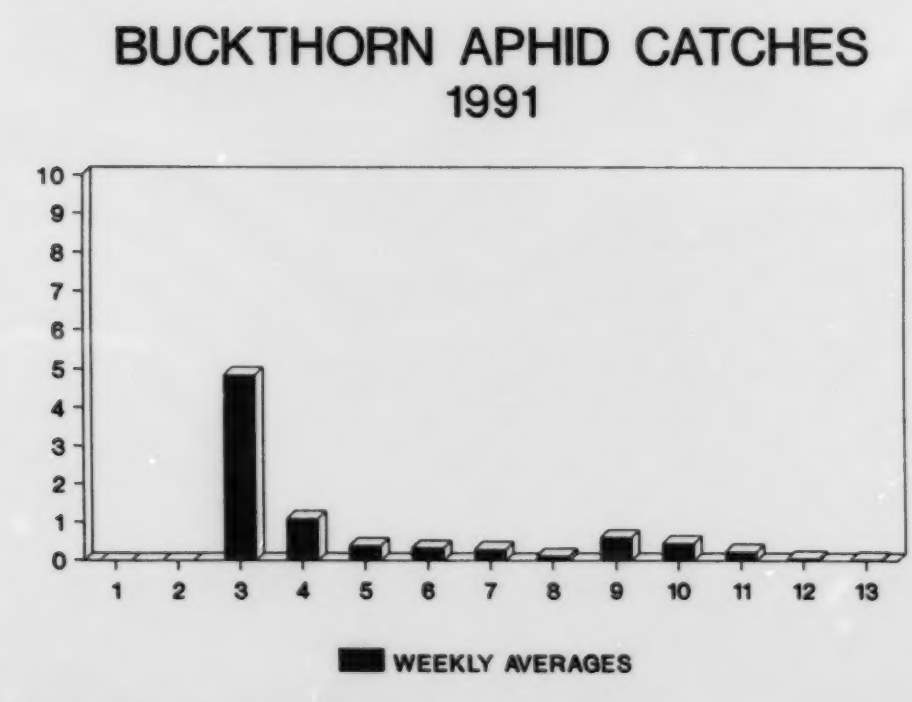
GRAPH #2



GRAPH #3

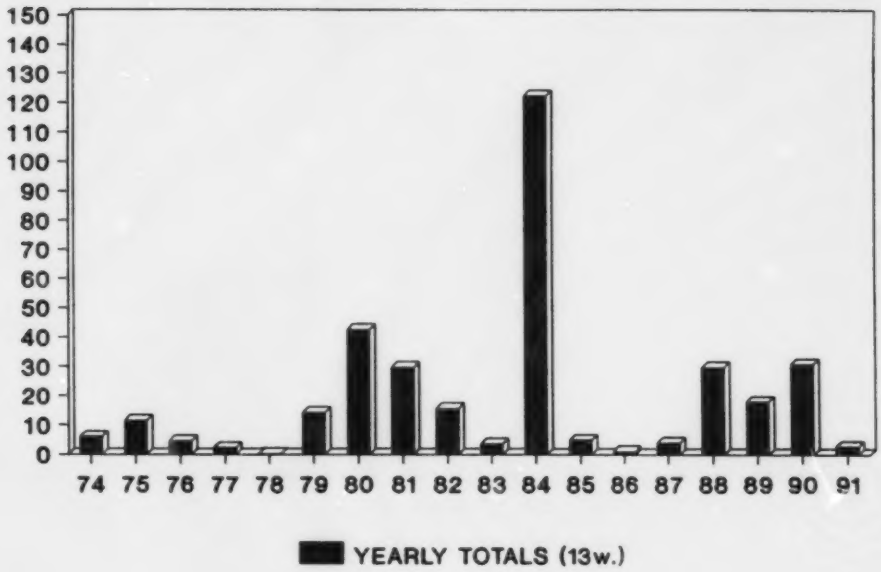


GRAPH #4



GRAPH #5

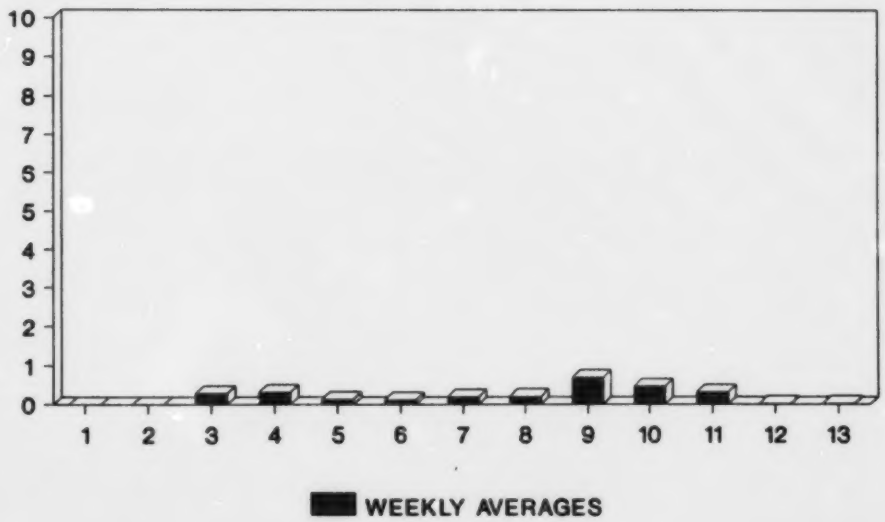
COMMON POTATO APHID CATCHES



TOTAL of AVERAGE WEEKLY CATCHES / PAN

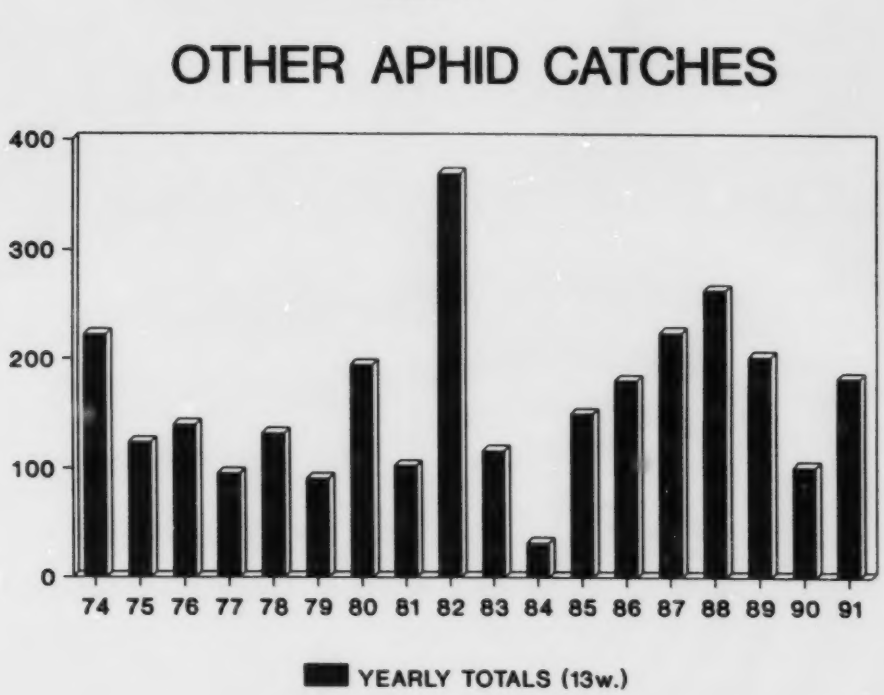
GRAPH #6

COMMON POTATO APHID CATCHES 1991

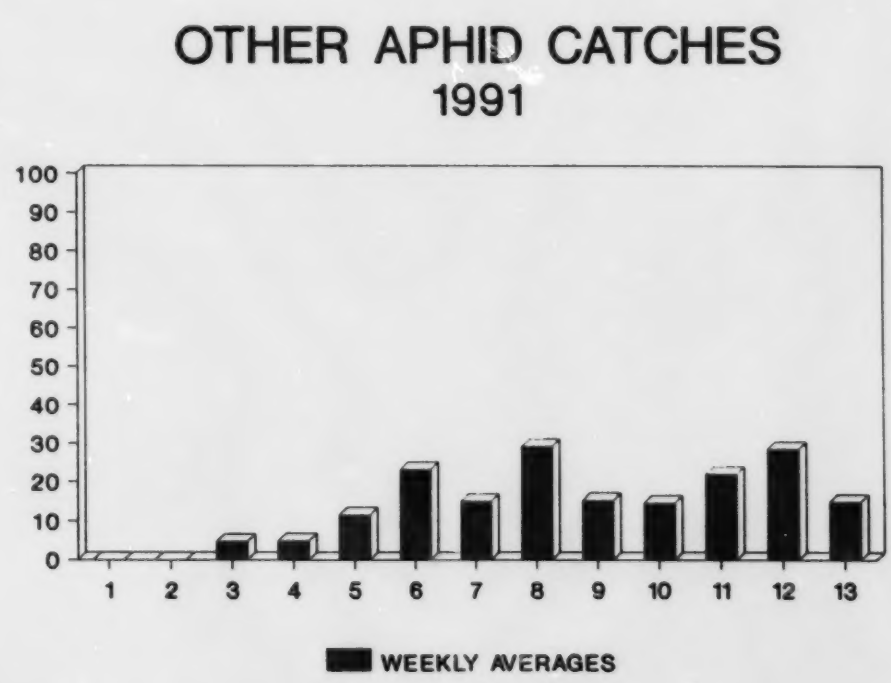


AVERAGE WEEKLY CATCHES / PAN

GRAPH #7


OTHER APHID CATCHES
400
300
200
100
0
74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91
YEARLY TOTALS (13w.)
TOTAL of AVERAGE WEEKLY CATCHES / PAN

GRAPH #8



MONITORING OF INSECT POPULATIONS IN POTATO FIELDS IN 1991

ENQUÊTE SUR LES INFESTATIONS D'INSECTES DANS LES CHAMPS DE POMMES DE TERRE EN 1991

GUY BERNARD

ABSTRACT:

Aphid populations were moderate during the 1991 season. Colorado Potato Beetle populations reached record high levels and were difficult to control with insecticides. Flea Beetle populations were similar to those of previous years and damage levels were generally low.

RÉSUMÉ:

Les populations de pucerons furent modérées durant la saison 1991. Les populations de doryphores atteignirent des niveaux record et furent difficiles à contrôler par l'emploi d'insecticides. Les populations d'altises furent similaires à celles des années précédentes et le niveau des dommages est demeuré généralement bas.

The most common insects in potato fields in New Brunswick are the Colorado Potato Beetle, several species of colonizing aphids and the Potato Flea Beetle. Colorado Potato Beetles are chewing insects. They can cause substantial reductions in yield if defoliation is extensive and occurs during a sensitive growth period.

Aphids are sucking insects. Many are vectors of virus diseases and as such, they are of particular concern to seed growers since tolerances for viruses are low in seed crops. Aphids can also reduce yields if infestations are severe.

Potato Flea Beetles are small insects which chew holes in potato leaves. Yield reductions are most likely to occur only if populations are very high late in the season.

In 1991, insect populations were monitored weekly in 35 fields in the potato belt. A sample area was established in each field early in the spring and data were collected from within the plot for a period of 13 weeks.

Aphid populations were estimated by counting the number of winged and wingless aphids of each species on the whole surface of one bottom, one middle and one top leaf per plant on a total of 30 plants per plot.

Colorado Potato Beetle infestations were evaluated by counting the number of larvae as well as adults in each plot on a total of 30 whole plants. Defoliation data were also collected again in 1991.

Flea beetle damage was evaluated by counting the number of feeding holes on the terminal leaflet of the fourth leaf from the top of the plant on 14 plants per plot.

The purpose of this data collection in potato fields was to provide growers with timely and easy to understand information that would help them better schedule insecticide applications and avoid unnecessary treatments. Field infestation data as it pertains to aphids has also been an essential complement to the aerial monitoring of aphids with yellow pan traps.

In 1991, as in previous years, an HP85 microcomputer was used to produce reports in the field immediately after monitoring. The reports clearly show the trends in aphid populations and provide growers with a visual evaluation of the success or failure of insecticidal treatments (Graph 1).

Data collected from the 35 fields sample is also used to provide information to all growers on field populations of insects. This information is available through the use of a toll-free telephone answering service and personal letters to producers.

To summarize the 1991 insect monitoring season: The percentage of fields infested with Potato Flea Beetles was high as usual in the spring. This percentage decreased sharply after mid-summer but augmented slightly again during the latter part of August. Damage levels generally remained low throughout the summer.

Aphid populations were generally moderate during the 1991 growing season. Buckthorn aphid populations were higher than those recorded during the previous three years. Numbers were highest in early August. Common potato aphid populations were generally low. The highest numbers occurred during the latter part of August. Green peach aphid populations were very low. Note that the prefix W as in WMP in the legend indicates that the graph refers to the winged form of a particular aphid.

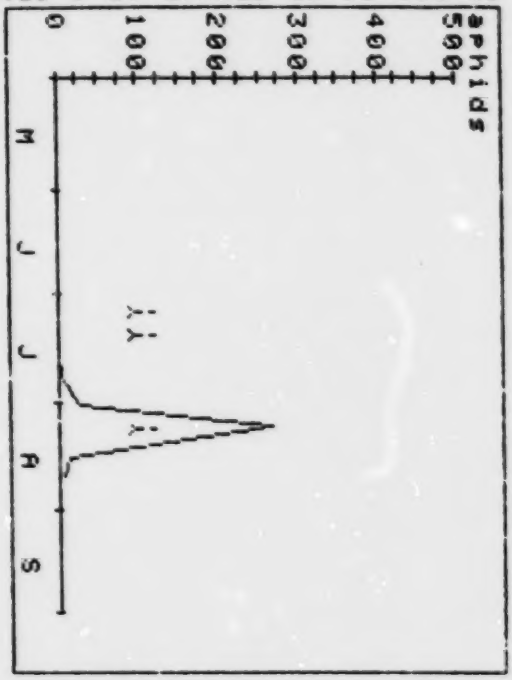
Colorado Potato Beetle populations reached new records in 1991. Unusually high numbers of overwintering adults appeared in the spring and caused damages to portions of fields soon after emergence. The percentage of fields infested with both adults and larvae remained high throughout the season and numbers, once again, exceeded the levels recorded in previous years. At the close of the 1991 season, 100% of the fields were still infested with adults and 88% were still infested with larvae. Unusually large numbers of adults were also detected in fields throughout the month of August and defoliation levels were sometime severe. Due to increased resistance levels, Colorado Potato Beetles were, this year again, more difficult to control with chemical insecticides.

The following graphs (Graph 2 to 12) depict the weekly status of insect populations in 35 potato fields during the summer of 1991. Although strongly biased by insecticide applications, they have nevertheless been included for the record and to provide a continuing basis for comparisons.

GRAPH #1

GROWER# 5
DATE:AUGUST 22
INSECTICIDE APPLICATIONS
7 / 6 SUPRAC 0 5L/A
7 / 13 THIODAN .5L/A
8 / 9 PIRIMOR 2.5KG/A

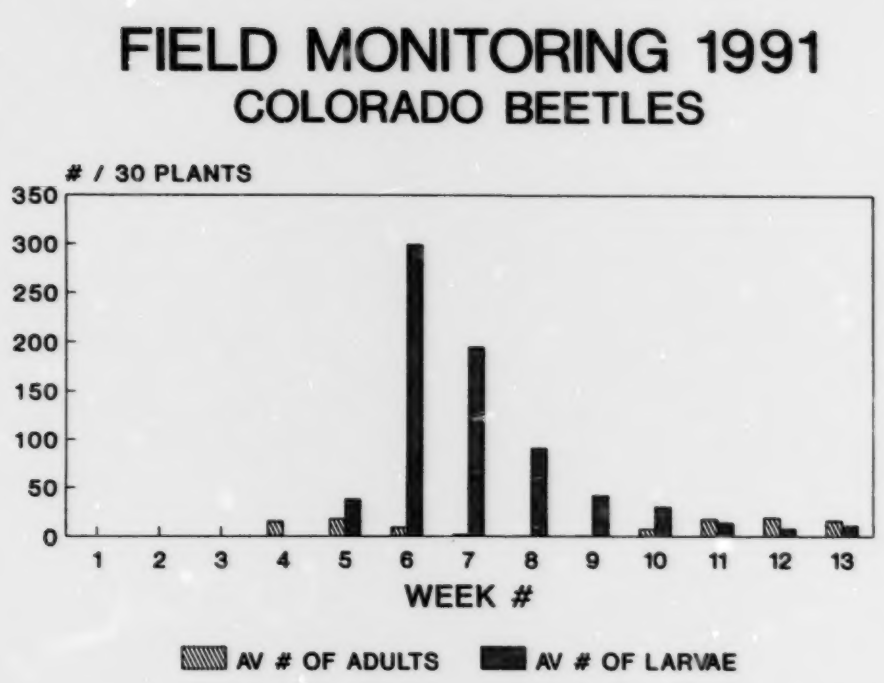
APHID POPULATION CURVE
total # of aphids on 90 leaves



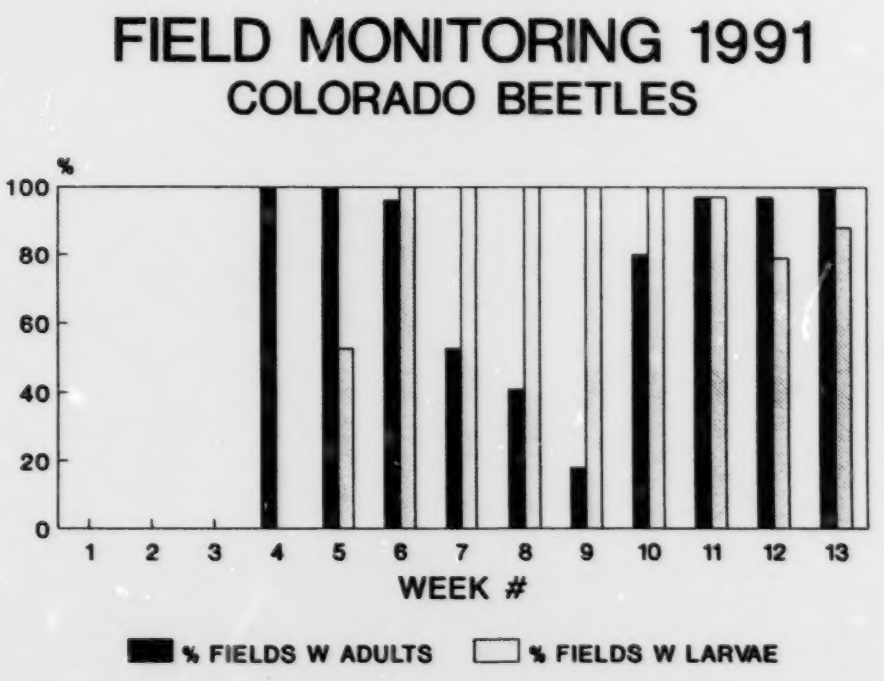
OF THE 9 APHIDS COUNTED
IN YOUR FIELD TODAY
1 WERE GREEN PEACH WINGED
3 WERE GREEN PEACH
0 WERE POTATO WINGED
5 WERE POTATO
0 WERE BUCKTHORN WINGED
0 WERE BUCKTHORN

19.8 % OF THE PLANTS
WERE INFESTED
AVERAGE FLEA BEETLE DAMAGE = 0
HOLES/LEAF
COLORADO BEETLES WERE DETECTED
IN YOUR FIELD
FOR MORE INFORMATION CALL GUY R

GRAPH #2

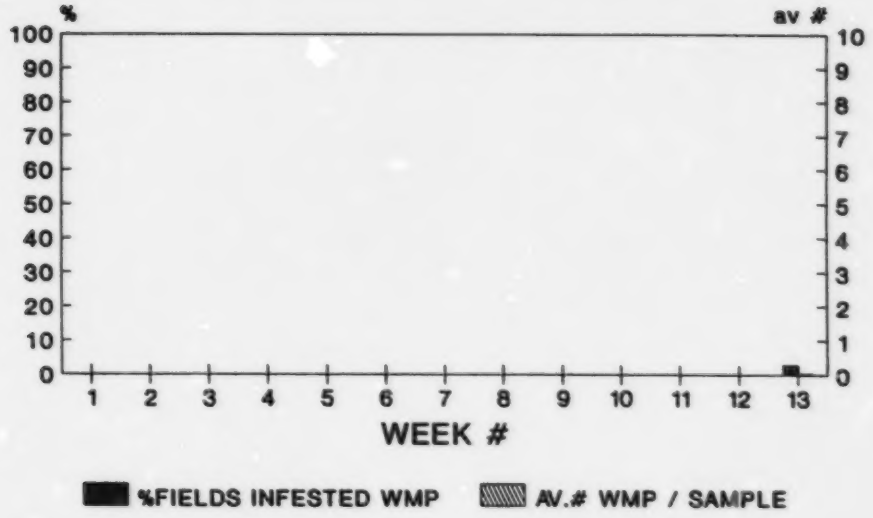


GRAPH #3



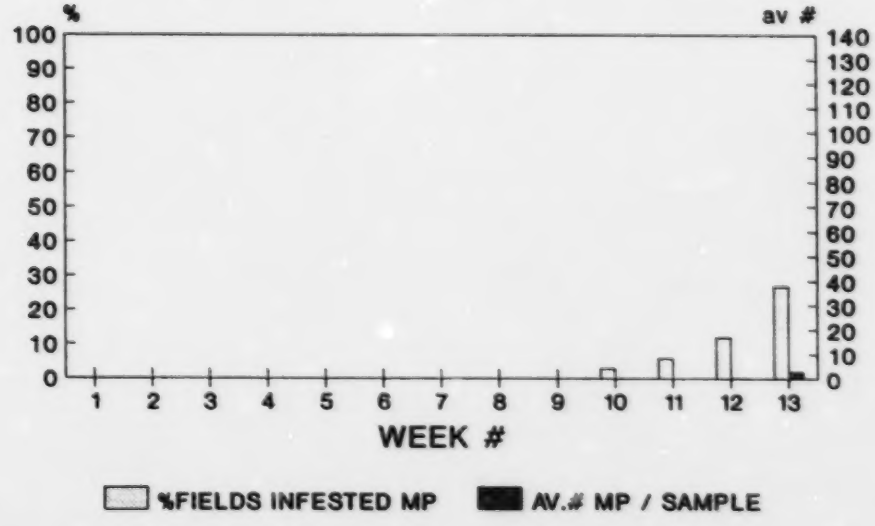
GRAPH #4

FIELD MONITORING 1991
GREEN PEACH APHIDS

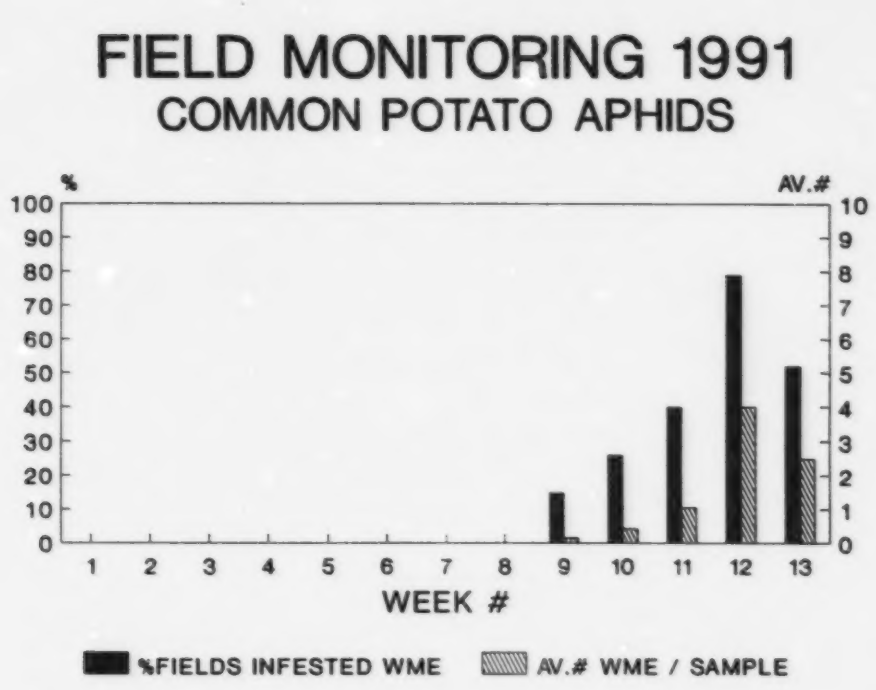


GRAPH #5

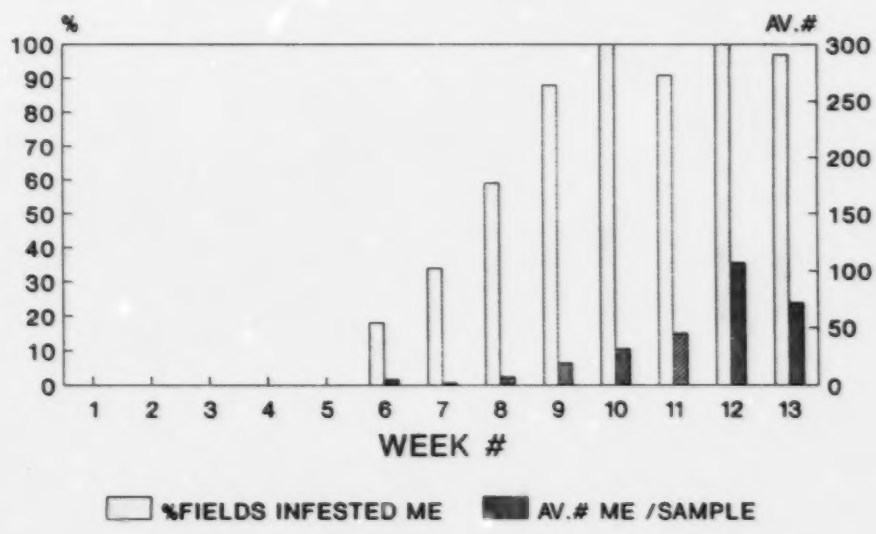
FIELD MONITORING 1991
GREEN PEACH APHIDS



GRAPH #6

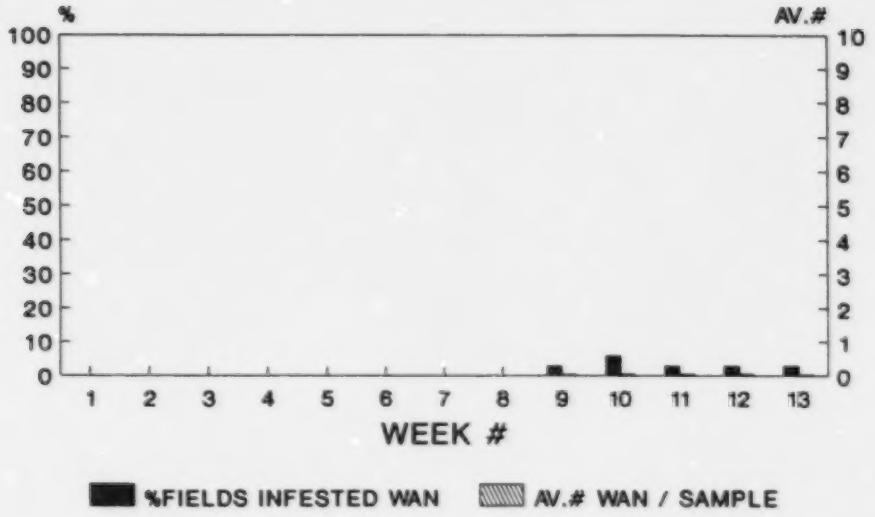


GRAPH #7



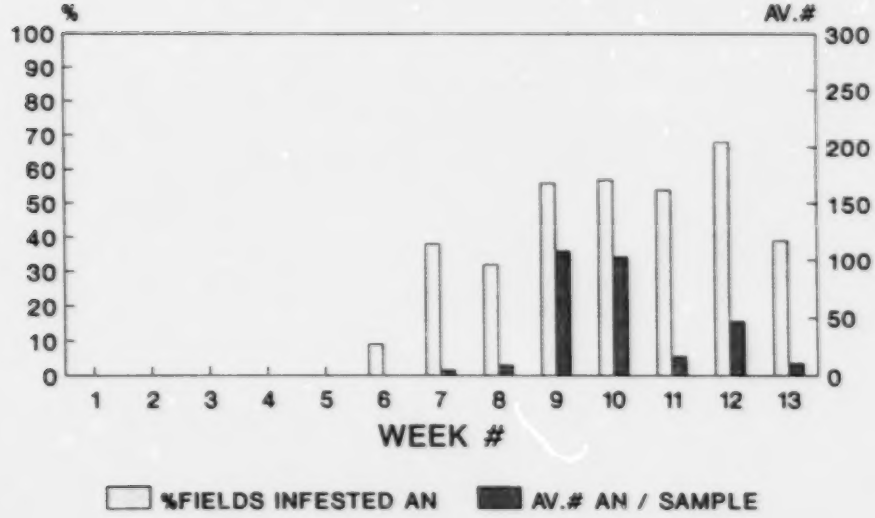
GRAPH #8

FIELD MONITORING 1991
BUCKTHORN APHIDS



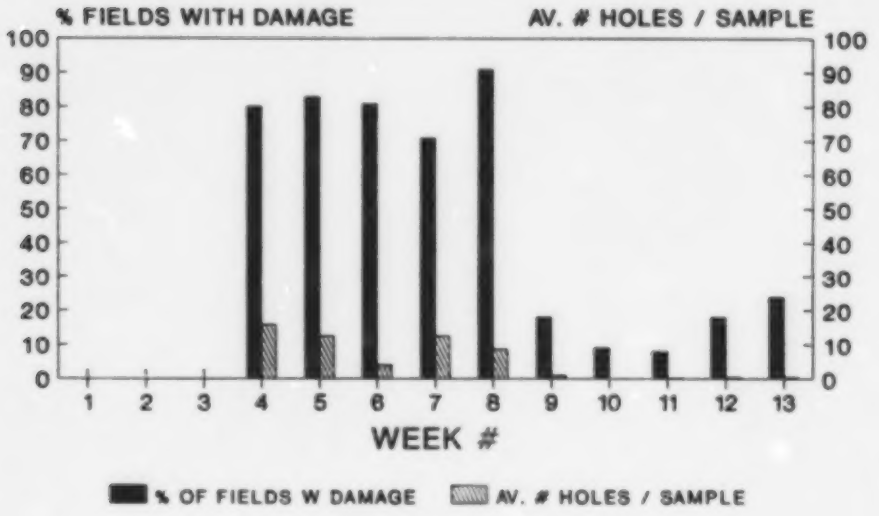
GRAPH #9

FIELD MONITORING 1991
BUCKTHORN APHIDS



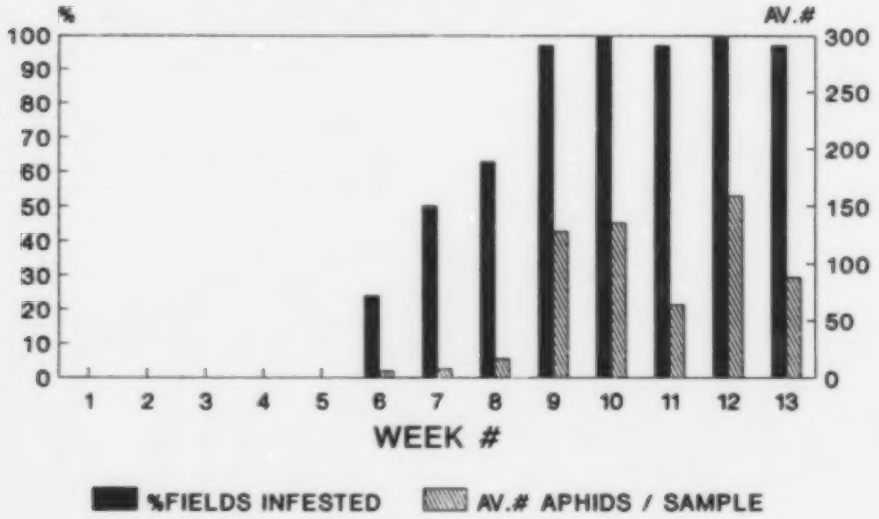
GRAPH #10

FIELD MONITORING 1991
FLEA BEETLE DAMAGE



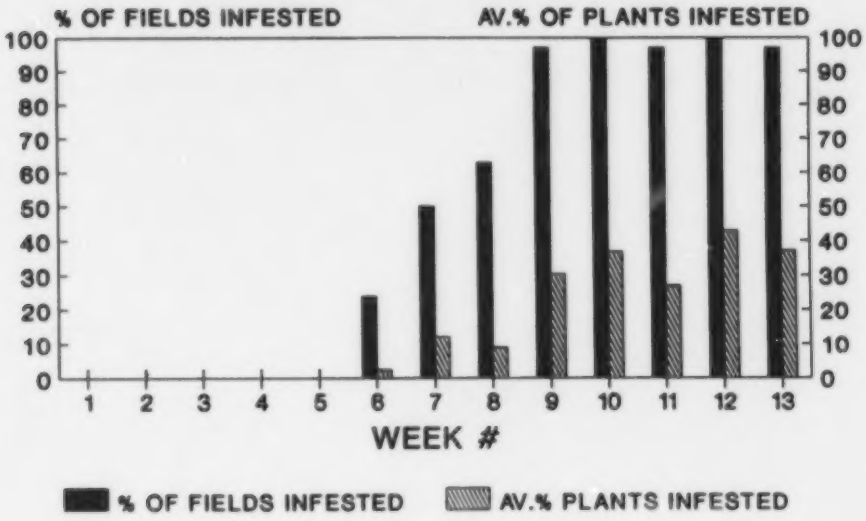
GRAPH #11

FIELD MONITORING 1991
TOTAL APHID INFESTATIONS



GRAPH #12

FIELD MONITORING 1991
% OF PLANTS INFESTED



EVALUATION OF ALTERNATIVE PRODUCTS INCLUDING Bt, KRYOCIDE AND INSECTIGONE FOR THE CONTROL OF COLORADO POTATO BEETLES ON POTATOES IN 1991

ÉVALUATION DE MÉTHODES ALTERNATIVES DE CONTRÔLE DU DORYPHORE TELLES L'USAGE DE PRODUITS INCLUANT LE Bt, LE KRYOCIDE ET L'INSECTIGONE DURANT LA SAISON 1991

GUY BERNARD

ABSTRACT: With the exception of the product Insectigone, all products were generally effective at diminishing populations of colorado potato beetle larvae on potato plants. The best yields were obtained in the Kryocide, Guthion and M-One/Guthion combination treatments. Alternative insecticides such as Kryocide, M-One, and MYX 1806 could be valuable in an integrated pest management program. Their use could slow the development of further resistances to commonly used chemical insecticides in our local beetle populations.

RÉSUMÉ: A l'exception du produit dénommé Insectigone, tous les produits à l'essai furent généralement efficaces à contrôler les larves de doryphore sur les plants de pommes de terre. Les meilleurs rendements furent obtenus avec le Kryocide, le Guthion et la combinaison M-One/Guthion. Les produits tels le Kryocide, le M-One et le MYX1806 pourraient, à cause de leur mode d'action particulier, être un outil utile dans un programme de lutte intégrée. L'usage de ces produits pourrait également diminuer le taux de développement de résistances aux insecticides chimiques parmi nos populations locales de doryphores.

INTRODUCTION:

Colorado potato beetle populations have been on the increase in recent years in New Brunswick. Both the larvae and the adult of the beetle are capable of causing substantial damage to potato plants. While plants are normally able to compensate for some damage, yield reductions are likely to occur if defoliation is too severe or if it is inflicted during a sensitive growth period or a period of stress.

The most common methods of reducing colorado potato beetle damage to potato crops in New Brunswick are the use of crop rotations and the use of chemical insecticides either banded in the soil at planting or sprayed on the foliage during the growing season.

The purpose of this experiment was to evaluate the effectiveness of Kryocide, Insectigone and two formulations of Bacillus thuringiensis (B.t.) as alternative control methods.

MATERIALS & METHODS:

A randomized complete block design was used for this experiment. Treatments were as follows:

CONTROL	Only water was used in this treatment
INSECTIGONE	An insecticidal powder (Diatomaceous earth) used at a rate of 11.2 kg/ha.
MYX 1806 (followed by **Guthion**)	Early applications of MYX1806 alone at a rate of 6 l/ha. followed later during the season by applications of Guthion at a rate of 1.75 l/ha.
MYX1806	An aqueous solution containing 10% encapsulated endotoxin of B.t. used at a rate of 6 l/ha.
KRYOCIDE	An insecticidal powder containing 96% sodium aluminofluoride and used at a rate of ll.2 kg/ha.
M-ONE (followed by **Guthion**)	Early applications of M-One alone at a rate of 7.5 l/ha. followed later during the season by applications of Guthion at a rate of 1.75 l/ha.
M-ONE	A 12.5% water dispersable suspension of B.t used at a rate of 7.5 l/ha.
GUTHION	An organo phosphate insecticide used at a rate of 1.75 l/ha.

The experiment was planted on May 16th, 1991, in the Wicklow area on ground likely to be infested with colorado potato beetles. Each treatment was replicated four times and consisted of two 4.57m rows of E2 Red Pontiac potatoes spaced 0.91m apart. Seed spacing was 30.5 cm between sets. Each seed piece was cut in advance to a weight of 50 g $\pm$ 5 g. Sets were planted by hand to ensure uniformity and accuracy. Fertilizer was applied by hand at a rate of 1120 kg/ha of 15-15-15. A 0.91m wide strip of wheat was seeded around each treatment after potato emergence to impede the movement of larvae and adults between plots. Weeding and hilling operations were also done by hand. A conventional backpack sprayer was used to apply the foliar treatments. All foliar treatments were applied in sufficient water to ensure thorough coverage. Dithane M-45 and Ridomil MZ were used to control foliar diseases.

A count was conducted on June 20th, before egg hatch had begun, to determine if there were large differences in infestation levels for each treatment, which may later influence the outcome of the experiment.

The following schedule of foliar applications was adopted:

The Control, Insectigone, MYX1806, M-One and Guthion plots were sprayed on each of the following dates: June 25, July 2, July 9, July 15, July 23 and July 29.

The combination treatments were sprayed with either M-One or MYX1806 on June 25, July 2 and July 9. These were followed by applications of Guthion on July 15, 23 and 29.

Reglone, a topkiller was applied to the experiment on August 12. The plots were harvested and yield data collected on August 19, 1991.

Observations on colorado potato beetle abundance were collected on June 19-20, July 4-5, July 11-12, July 17-18, July 25-26, July 31-August 1 and August 8. In all instances, data were collected on all plants in each treatment.

RESULTS:

ADULTS & EGG MASSES

The results indicate (Graph 1, Table 1) that prior to the application of any spray, initial dispersion of adults within the experimental site and their subsequent egg depositions were relatively even. At the start of the experiment, populations of adults varied from a low of 2.16 to a high of 2.59 beetles per plant. The average number of egg masses per plant varied from a low of 4.41 to a high of 5.13.

On July 4 & 5, after the application of a second spray, populations of adults were significantly higher (Graph 2, Table 2) in the Kryocide treatment when compared to all others. Similarly the number of egg masses layed on plants in that treatment was significantly higher than all others with the exception of the Guthion treatment. It is interesting to note that the treatments where the least egg laying occurred were also the treatments which had significantly higher numbers of small and large larvae, indicating a possible preference by adults for egg deposition on relatively uninfested plants (see correlations, Table 9, as well as individual values in other tables).

On July 11 & 12, after the application of the third spray, adult beetle populations and egg masses were still highest for the Kryocide treatments (Graph 3, Table 3).

By July 17 & 18, differences in infestations by adults were not significant: having completed their life cycle, fewer adults remained on the plants. Egg masses still remained highest for the Kryocide treatment (Graph 4, Table 4).

The new generation of adult beetles originating from larvae, which had escaped the various treatments, started emerging from the ground on July 23. The number of adults on the plants after this date was therefore a reflection of larval survival in each treatment. On July 25-26, numbers of adults were significantly higher in the Insectigone treatment when compared to all others (Graph 5, Table 5). Next highest populations were found in the Control but these were not statistically different from those in the M-One and MYX1806 treatments. Differences in egg mass abundance were not significant.

Similar results for both adults and egg masses were obtained on July 31 & August 1 (Graph 6, Table 6). Insectigone and the Control had the highest populations of adults followed by M-One and MYX1806. MYX1806 populations were not statistically different however from those in the Kryocide, Guthion and Guthion combination treatments. By August 8th, results of counts were somewhat distorted as adults had completely defoliated some treatments and were starting to disperse. Numbers were highest in the M-One and MYX1806 treatments (Graph 7, Table 7).

LARVAE

Results of the first count on July 4 & 5 indicate that Guthion was significantly better than other treatments in suppressing populations of young larvae (Graph 2, Table 2). This seems to point to a difference in rapidity of action rather than efficacy as large larvae were effectively controlled in all treatments when compared with the Control and Insectigone treatments.

On July 11 & 12, Guthion and Kryocide effectively controlled small larvae. Large larvae were best controlled in the Kryocide, Guthion, M-One and M-One/Guthion combination treatments (Graph 3, Table 3). Large larvae populations were also significantly reduced in the MYX1806 and MYX1806/Guthion combination treatments when compared to the Control and Insectigone treatments.

By July 17 & 18, after the first application of Guthion in the Guthion combination treatments, small larvae populations were still lowest in the Kryocide and the Guthion treatments (Graph 4, Table 4). Small larvae populations were unusually low in the Insectigone and Control treatments. This distortion was thought to be a consequence of reduced egg laying by adults in these treatments during the previous week.

Kryocide, Guthion and Guthion combination treatments had the lowest number of large larvae but all treatments reduced populations significantly when compared to the Control and Insectigone.

By July 25 & 26, small larvae populations were again somewhat distorted. Large larvae control was again best in the Guthion, Kryocide and the Guthion combination treatments (Graph 5, Table 5).

By July 31 & August 1, small larvae population differences were not significant and large larvae counts were lowest in the Guthion, Kryocide and the Guthion combination treatments, but distortion was also apparent as few large larvae remained in the Insectigone treatment (Graph 6, Table 6).

On August 8, ten days after the application of the last spray, small larvae population differences were not significant while large larvae populations were highest in the M-One and MYX1806 treatments (Graph 7, Table 7).

YIELDS:

Total yield data collected on August 19, 1992, indicated the best treatments were Kryocide and Guthion. These were not significantly different, however, from the yields obtained in the M-One/Guthion combination treatments. All treatments were effective in preventing significant decreases in yield when compared with the Insectigone and Control treatments (Graph 8, Table 8).

CONCLUSIONS:

Kryocide did not provide control of the adults but was as effective as the chemical insecticide Guthion at reducing larvae populations of colorado potato beetles on potato plants. The biological insecticides M-One and MYX1806 were also useful in this respect as were the M-One/Guthion and MYX1806/Guthion combination treatments. Large populations of ladybird beetles were observed on the Kryocide treatment during the summer. Kryocide, M-One and MYX1806, because of their mode of action, provide an alternative to the use of conventional chemicals. This also makes them valuable in the fight against the development of further resistances to chemical insecticides in our local beetle populations.

* The author wishes to express his appreciation for the efforts and dedication of Wayne Dingee and Colleen Trevors who worked assiduously on this project.

GRAPH #1

BIOLOGICAL CONTROL STUDY 1991
June 19,20 counts

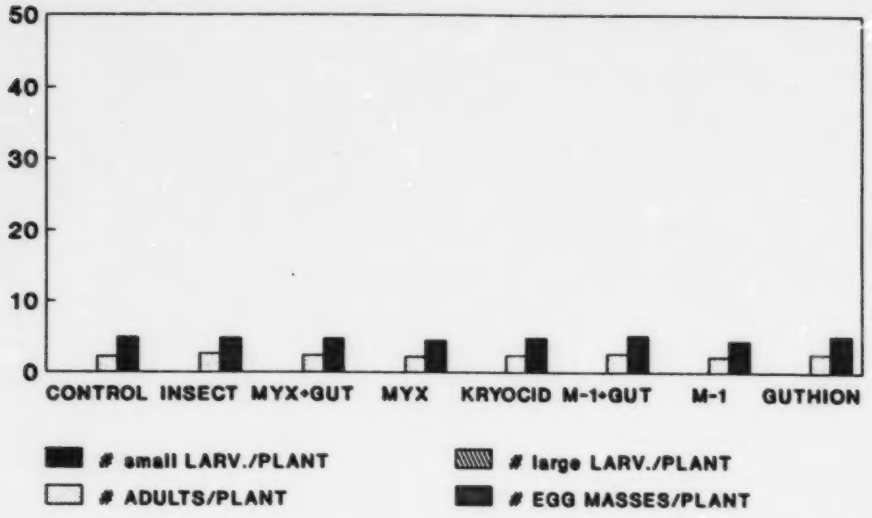


TABLE #1 JUNE 19, 20 COUNTS		
	n.s. # ADULTS/PLANTS	n.s. # EGG MASSES/PLANT
Control (0)	2.16	4.88
Insectigone (0)	2.58	4.84
MYX 1806 (0) and Guthion (0)	2.38	4.74
MYX 1806 (0)	2.20	4.48
Kryocide (0)	2.37	4.78
M-One (0) and Guthion (0)	2.57	5.13
M-One (0)	2.21	4.41
Guthion (0)	2.59	5.11

( ) = # of applications of specific product
n.s. = No significant difference between means
* = significant difference between means (5% level)

GRAPH #2

BIOLOGICAL CONTROL STUDY 1991
July 4,5 counts

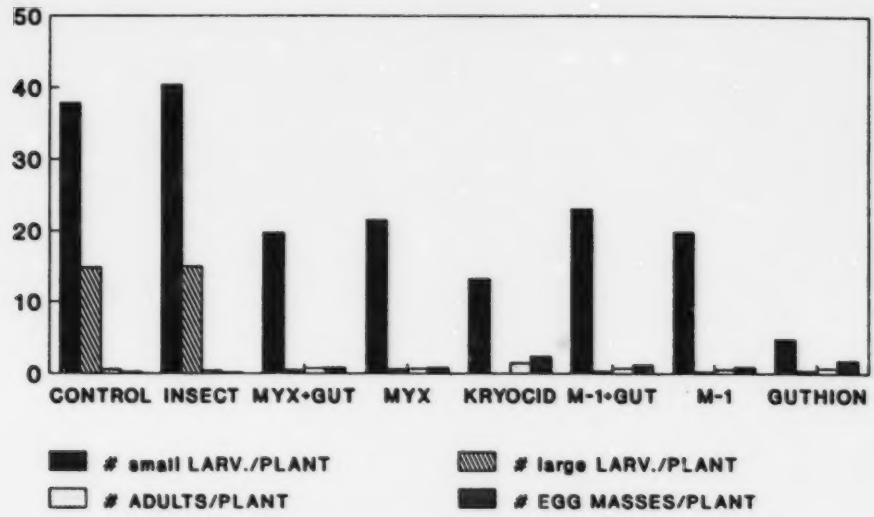


TABLE #2
JULY 4 & 5 COUNTS

	* # small larvae /plant	* # large larvae /plant	* # adults /plant	* # egg masses /plant
Control (2)	37.87 a	14.81 a	0.53 b	0.24 d
Insectigone (2)	40.45 a	14.98 a	0.37 b	0.18 d
MYX 1806 (2) & Guthion (0)	19.70 bc	0.51 b	0.70 b	0.85 cd
MYX 1806 (2)	21.55 bc	0.58 b	0.67 b	0.80 cd
Kryocide (2)	13.20 c	0.00 b	1.47 a	2.33 a
M-One (2) and Guthion (0)	23.07 b	0.29 b	0.72 b	1.19 bc
M-One (2)	19.86 bc	0.21 b	0.57 b	0.92 c
Guthion (2)	4.8 d	0.44 b	0.71 b	1.79 ab

( ) = # of applications of specific product
n.s. = No significant difference between means
* = significant difference between means (5% level)

GRAPH #3

BIOLOGICAL CONTROL STUDY 1991
July 11,12 counts

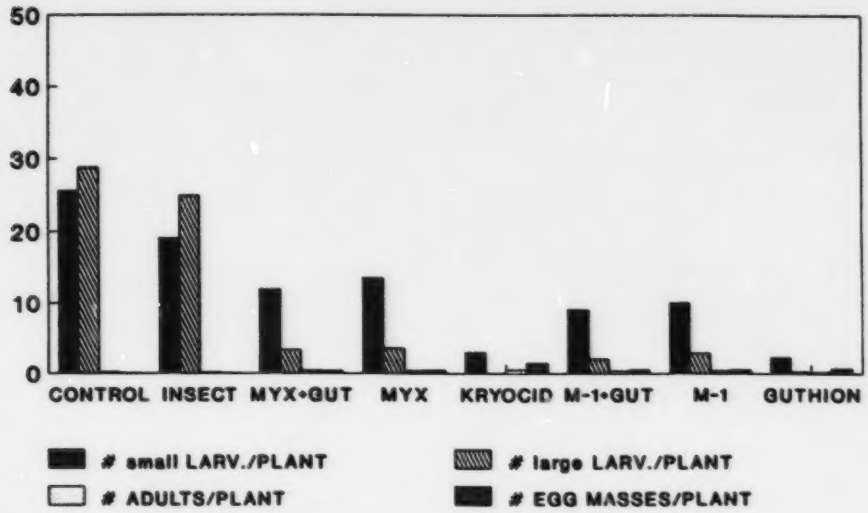


TABLE #3
JULY 11 & 12 COUNTS

	* # small larvae /plant	* # large larvae /plant	* # adults /plant	* # egg masses /plant
Control (3)	25.64 a	28.77 a	0.20 bc	0.05 c
Insectigone (3)	19.13 b	24.94 b	0.14 c	0.05 c
MYX 1806 (3) & Guthion (0)	11.89 c	3.30 c	0.36 ab	0.37 bc
MYX 1806 (3)	13.61 c	3.58 c	0.37 ab	0.46 bc
Kryocide (3)	3.04 d	0.07 d	0.54 a	1.48 a
M-One (3) and Guthion (0)	9.12 c	2.02 cd	0.37 ab	0.59 b
M-One (3)	10.07 c	2.87 cd	0.38 ab	0.59 b
Guthion (3)	2.28 d	0.30 d	0.22 bc	0.70 b

( ) = # of applications of specific product
n.s. = No significant difference between means
* = significant difference between means (5% level)

GRAPH #4

BIOLOGICAL CONTROL STUDY 1991
July 17,18 counts

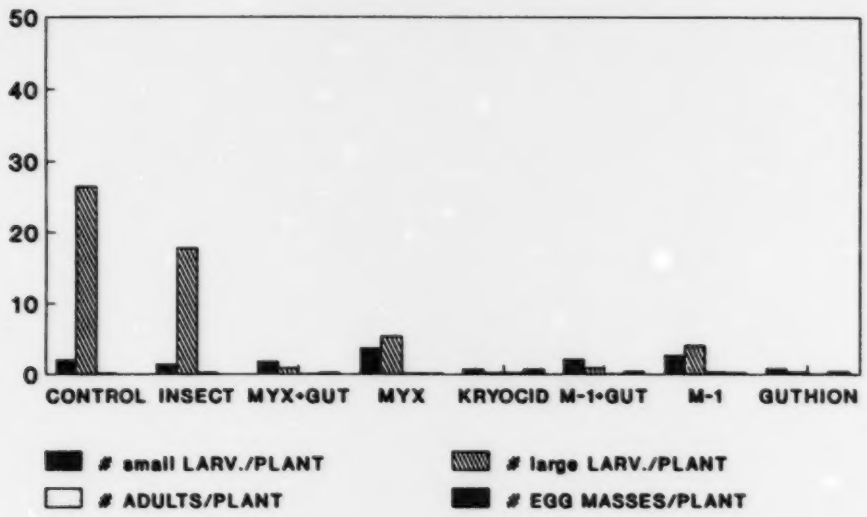


TABLE #4
JULY 17 & 18 COUNTS

	* # small larvae /plant	* # large larvae /plant	n.s. # adults /plant	* # egg masses /plant
Control (4)	2.03 bc	26.54 a	0.12	0.00 d
Insectigone (4)	1.36 cd	17.85 b	0.21	0.00 d
MYX 1806 (3) & Guthion (1)	1.81 c	0.93 d	0.11	0.23 bc
MYX 1806 (4)	3.68 a	5.37 c	0.17	0.13 cd
Kryocide (4)	0.77 d	0.22 d	0.22	0.72 a
M-One (3) and Guthion (1)	2.10 bc	0.90 d	0.10	0.38 b
M-One (4)	2.70 b	4.03 cd	0.30	0.25 bc
Guthion (4)	0.81 d	0.31 d	0.10	0.42 b

( ) = # of applications of specific product
n.s. = No significant difference between means
* = significant difference between means (5% level)

GRAPH #5

BIOLOGICAL CONTROL STUDY 1991
July 25,26 counts

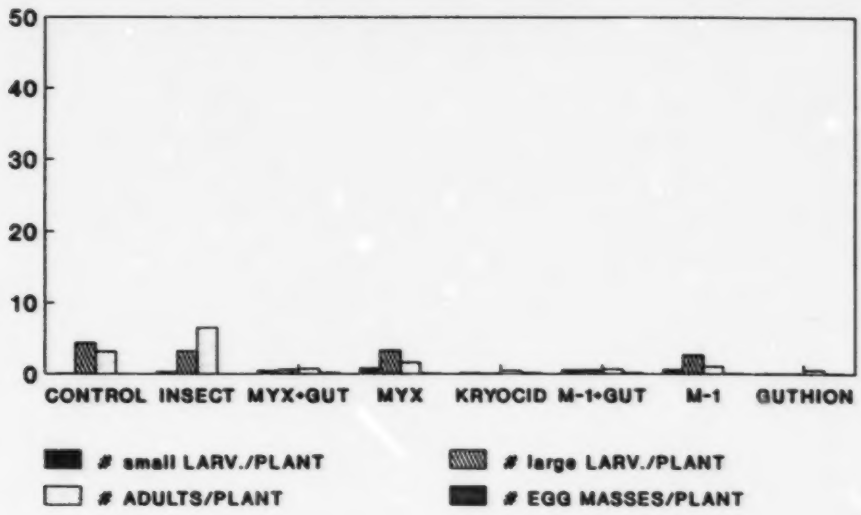


TABLE #5
JULY 25 & 26 COUNTS

	* # small larvae /plant	* # large larvae /plant	* # adults /plant	n.s. # egg masses /plant
Control (5)	0.09 d	4.36 a	3.15 b	0.00
Insectigone (5)	0.35 bcd	3.29 a	6.54 a	0.00
MYX 1806 (3) & Guthion (2)	0.49 abcd	0.62 bc	0.75 c	0.15
MYX 1806 (5)	0.79 a	3.34 a	1.61 bc	0.11
Kryocide (5)	0.18 cd	0.11 c	0.46 c	0.19
M-One (3) and Guthion (2)	0.54 abc	0.61 bc	0.68 c	0.16
M-One (5)	0.65 ab	2.69 ab	1.04 bc	0.10
Guthion (5)	0.07 d	0.09 c	0.58 c	0.11

( ) = # of applications of specific product
n.s. = No significant difference between means
* = significant difference between means (5% level)

GRAPH #6

BIOLOGICAL CONTROL STUDY 1991

July 31,Aug 1 counts

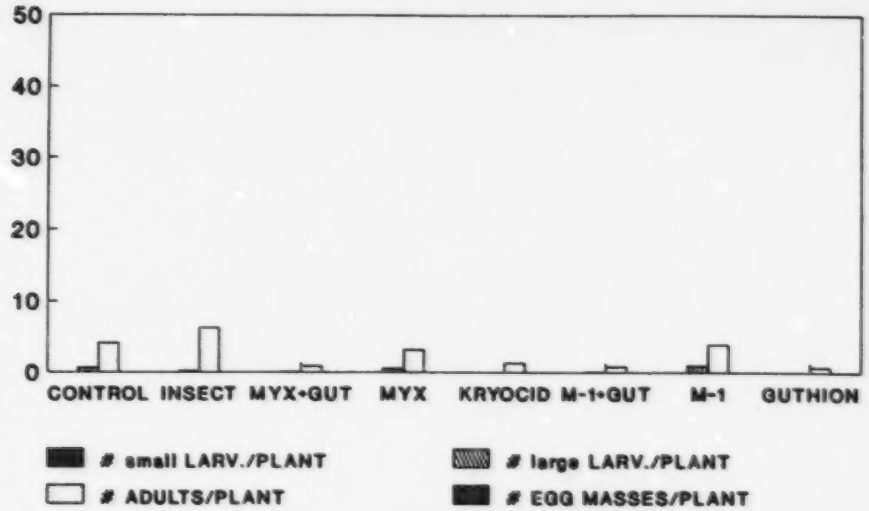


TABLE #6
JULY 31 & AUGUST 1 COUNTS

	n.s. # small larvae /plant	* # large larvae /plant	* # adults /plant	n.s. # egg masses /plant
Control (6)	0.02	0.61 ab	4.13 ab	0.00
Insectigone (6)	0.04	0.23 b	6.24 a	0.00
MYX 1806 (3) & Guthion (3)	0.00	0.09 b	0.87 d	0.04
MYX 1806 (6)	0.00	0.59 ab	3.20 bcd	0.02
Kryocide (6)	0.00	0.03 b	1.30 cd	0.04
M-One (3) and Guthion (3)	0.00	0.08 b	0.79 d	0.04
M-One (6)	0.00	0.93 a	3.93 abc	0.00
Guthion (6)	0.00	0.00 b	0.76 d	0.01

( ) = # of applications of specific product
n.s. = No significant difference between means
* = significant difference between means (5% level)

GRAPH #7

BIOLOGICAL CONTROL STUDY 1991
Aug 8 counts

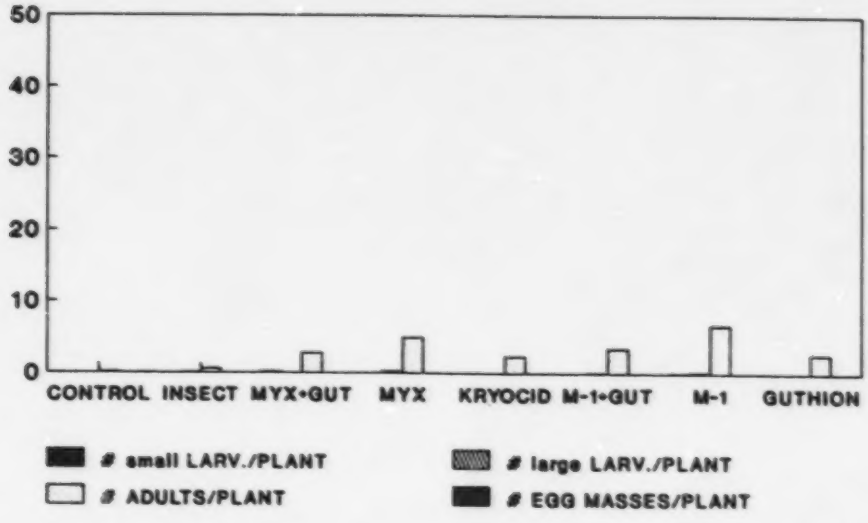


TABLE #7
AUGUST 8 COUNTS

	n.s. # small larvae /plant	* # large larvae /plant	* # adults /plant	n.s. # egg masses /plant
Control (6)	0.00	0.01 c	0.16 d	0.00
Insectigone (6)	0.00	0.05 c	0.56 cd	0.00
MYX 1806 (3) & Guthion (3)	0.12	0.03 c	2.77 bcd	0.00
MYX 1806 (6)	0.02	0.21 a	4.94 ab	0.00
Kryocide (6)	0.00	0.00 c	2.39 bcd	0.00
M-One (3) and Guthion (3)	0.00	0.07 bc	3.49 bc	0.00
M-One (6)	0.08	0.18 ab	6.75 a	0.00
Guthion (6)	0.00	0.00 c	2.64 bcd	0.00

( ) = # of applications of specific product
n.s. = No significant difference between means
* = significant difference between means (5% level)

GRAPH #8

BIOLOGICAL CONTROL STUDY 1991

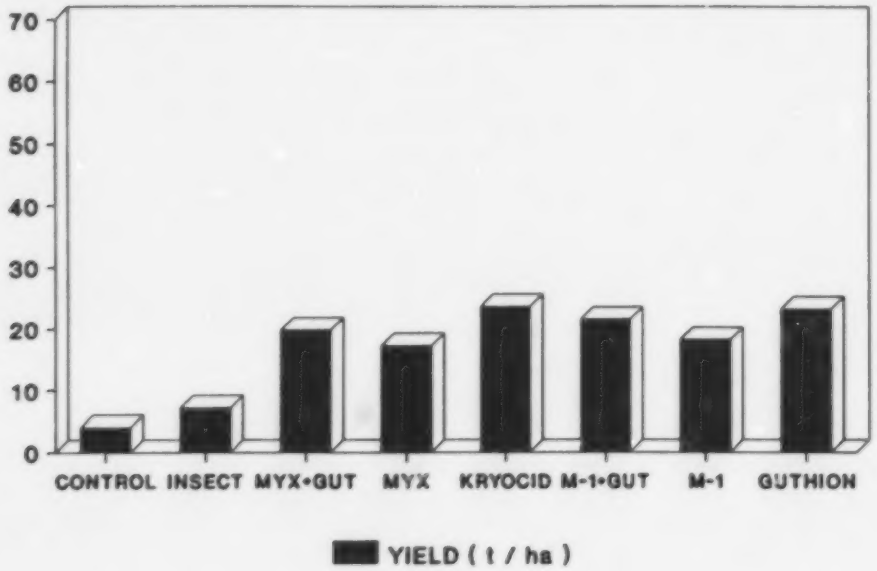


TABLE #8	
	* TOTAL YIELD t/ha.
Control (6)	4.02 f
Insectigone (6)	7.17 e
MYX 1806 (3) and Guthion (3)	19.82 bc
MYX 1806 (6)	17.28 d
Kryocide (6)	23.62 a
M-One (3) and Guthion (3)	21.53 ab
M-One (6)	18.24 cd
Guthion (6)	23.28 a

( ) = # of applications of specific product
n.s. = No significant difference between means
* = significant difference between means (5% level)

TABLE #9

TABLE CORRELATION TABLES *

X Variable	Y Variable	Corr (r)	Slope (b)	Y Int (a)	n-2
SMLV-JL11	LGLV-JL11	0.8214571495	1.1649321295	-5.5704863166	30
SMLV-JL11	ADULTS-JL11	-0.4145581825	-0.0088177672	0.4316835521	30
SMLV-JL11	EGG MS-JL11	-0.6873655873	-0.0429580792	1.0484550876	30
LGLV-JL11	SMLV-JL11	0.8214571495	0.579254217	7.08064754	30
LGLV-JL11	ADULTS-JL11	-0.508865784	-0.0076323921	0.3900378642	30
LGLV-JL11	EGG MS-JL11	-0.6300223569	-0.0277649772	0.7680109103	30
ADULTS-JL11	SMLV-JL11	-0.4145581825	-19.490023194	18.227516964	30
ADULTS-JL11	LGLV-JL11	-0.508865784	-33.927028533	19.335187148	30
ADULTS-JL11	EGG MS-JL11	0.4507800583	1.3244898326	0.1060184829	30
EGG MS-JL11	SMLV-JL11	-0.6873655873	-10.998430541	17.782903473	30
EGG MS-JL11	LGLV-JL11	-0.6300223569	-14.296002046	15.945593604	30
EGG MS-JL11	ADULTS-JL11	0.4507800583	0.1534195702	0.2444368193	30

* all correlations are significant at the .05 level.

Pesticide Resistance Testing of New Brunswick Colorado Potato Beetle Populations in 1991

Détermination du niveau de résistance aux pesticides parmi les populations locales de doryphores du Nouveau-Brunswick en 1991

Guy Bernard

Abstract:

Forty-two samples of adult colorado potato beetles were tested in the laboratory using 15 different chemicals at 5 different concentrations. Results indicate that there were widespread differences in mortality ratings between the different chemicals.

Résumé:

Quarante-deux échantillons de doryphores adultes furent testés en laboratoire à l'aide de 15 différents insecticides utilisés selon 5 différentes concentrations. Les résultats démontrent qu'il existe de grandes variations dans les taux de mortalité des divers produits.

INTRODUCTION:

Populations of colorado potato beetles in New Brunswick potato fields have been increasing regularly each year for the past five or six years. They have recently reached levels that are intolerable because of the yield decreases they have engendered.

Yield decreases in the potato crop are known to occur when beetle population levels reach an average of 2 adults or larvae per plant. These levels are especially harmful to the crop when they are encountered during the flowering period. In New Brunswick, the 1989 season was the first where average colorado potato beetle populations caused perceptible yield reductions in our potato fields. The situation worsened in 1990 as average population levels surpassing the thresholds were maintained for a period of two consecutive weeks during a critical growth period. Field infestation levels with larvae remained high for a large part of the growing season, indicating the degree of difficulty growers were experiencing in trying to achieve control.

Infestations of colorado potato beetles were rare in the province a decade ago and colorado potato beetle numbers were so low that it was difficult to devise a proper monitoring technique to assess their numbers. However, after having been exposed for so long to chemicals with essentially similar modes of action, beetles have gradually become resistant to most of the chemicals now registered to control them. These resistances are well documented in the province.

In a study conducted during the summer of 1990 in cooperation with Dr. Gilles Boiteau, Agriculture Canada, Fredericton, colorado potato beetle samples from 27 New Brunswick potato fields were sent to Ms. Stephanie Turnbull of Agriculture Canada and tested for resistance to common insecticides at her London, Ontario research laboratory. Although the tests were conducted with few chemicals, the results indicated that there were widespread resistances to the chemicals tested.

Resistances to Furadan varied from 2 x to 100 x the level found in susceptible populations. Resistance to Decis varied from 3 x to 17 x; resistance to Guthion from 1 x to 10 x; resistance to Thiodan from 4 x to 20 x; resistance to Belmark from 3 x to greater than 25 x; and resistance to Cymbush from 6 x to 20 x. Overall results showed that generally resistance levels were lowest for Guthion and the synthetic pyrethroids as a class of chemicals.

During the course of the 1990 season, it became increasingly apparent that results with a particular chemical were extremely variable as effectiveness varied from farm to farm depending on the previous spray history of the fields and the specific resistances beetles had developed.

Without the benefit of knowledge concerning levels of acquired resistances, potato growers would likely apply numerous ineffective insecticidal sprays and the crop would suffer consequent reductions in yields. In the spring of 1991, to avoid this scenario, we resolved to find and apply a quick resistance test in order to help our growers determine which insecticides still offered the best chances of success on their farms.

Several diagnostic techniques were available to determine resistance levels in the beetles. Filter paper tests had been developed by Bishop and Grafius of Michigan State University as well as French, Kennedy and Lampert of North Carolina State University. A dip test had also been developed by Roush, Beckley and Ferro of Cornell University in New York. In this test, samples of 10 adult beetles were dipped in diagnostic solutions of chemical insecticides. These diagnostic concentrations were calibrated to kill 99% of a susceptible strain of the beetle. Field verification of the technique showed that it was generally a good indicator of field efficacy. Use of a particular insecticide was recommended if mortality in the test was greater than 90% with foliar insecticides and greater than 50% with granular soil applied insecticides. Only one concentration, the diagnostic concentration, was used in this test. With this procedure, strainers were used to dip the beetles and disposable cups were used to hold them overnight.

We decided to adopt a similar technique but since supplies of susceptible strains of the beetle were unavailable on short notice for the determination of a diagnostic concentration, we resolved to use the recommended field dosages as indicated on the labels as our base concentration. Provisions were made however to obtain a susceptible strain of the beetle to use at a later date as a standard for comparison in our procedure.

For the purpose of our test, we assumed that the highest label rates, as recommended by the manufacturers and which had adequately controlled beetles in the past (ie., when populations were susceptible) would provide a suitable diagnostic concentration. We otherwise modified the Cornell procedure as described below but the essential principle of dipping beetles in insecticide solutions to assess mortality remained the same.

MATERIALS & METHODS:

The availability of the test was publicised in our newsletter during early spring of 1991, and growers were asked to bring a sample of 800 adult beetles to our Potato Centre in Wicklow. Growers were advised to place the beetles in an empty ice cream container filled with shredded absorbent paper and covered with a doubled nylon stocking fastened to the container with an elastic band.

One litre solutions of the 15 different chemicals recommended for use in New Brunswick were prepared and placed in glass mason jars using distilled water. The maximum label recommended rate of the chemical in the recommended amount of water per ha. (500 L/ha. in all cases) was used as the basis for preparing the solutions. Granular insecticides solutions were also prepared using the same criteria. Distilled water only was used as a CONTROL. 4 different concentrations of the chemical insecticides were used:

1 - the recommended field rate
5 - Five times the recommended field rate
10 - Ten times the recommended field rate
20 - Twenty times the recommended field rate

Samples of 10 adult beetles were placed in nylon mesh bags held by a clamp and dipped briefly in the appropriate chemical solution. Each field sample was therefore tested using 15 chemicals each at 5 different rates.

The mesh bags containing the beetles were then placed on a board fitted with pegs and allowed to stand until the next day, usually for a period of about 20 hours before they were removed.

The beetles were then transferred to styrofoam soup dishes and placed under lights. Beetles were arbitrarily considered to be dead if they could not walk out of the dish after a period of 5 minutes.

A test result sheet such as the sample shown (Appendix 1,2) was delivered to the growers as soon as possible after completion of the tests. A rating of 10 indicates 100% mortality. A rating of 0 indicates that all the beetles survived the treatment.

RESULTS & DISCUSSION:

Our purpose with the test was to identify chemicals for which survival was obvious at 1x, 5x, 10x and 20x the field concentration. Survival at those rates was a likely indicator of possible resistance in the population. We recognized that temperature and other environmental factors as well as method of exposure would differ between laboratory and field conditions and would play a large role in determining the actual level of field efficacy. We realized also that since our test was based solely on the effectiveness of the contact mode of action of the chemicals involved, we might be discriminating somewhat against chemicals for which ingestion might play a role in beetle control in the field. We presumed, however, that the most auspicious insecticides to use would be those for which no beetles survived any of the rate treatments with the exception of the control.

Overall, the test was very satisfactory in spite of certain difficulties that sometimes made interpretation difficult. The most troublesome was that a proportion of the beetles would go into a cataleptic state after being transferred to the dishes. In this state, they appeared to be dead, but would often recover after the mortality rating had been noted. This was particularly obvious in the control treatment with distilled water only as the beetles were not affected and retained and utilized their normal defense mechanisms.

This explains in part the apparently high mortality rating which was recorded for the control. Another factor contributing to the high mortality was the poor condition of some of the samples which were brought to our lab and the fact that some of the spring beetles normally die after having completed their life cycle.

A total of 42 samples were tested in our laboratory during the spring of 1991. Our results indicate that there were widespread differences in efficacy level between the chemicals tested (Appendix 3-18). The chemicals which showed the most effectiveness in our test were Guthion and the synthetic pyrethroids as a group. Unfortunately, because of rearing problems experienced by our supplier, we did not obtain susceptible beetles for comparison and were therefore unable to appraise resistance levels per se.

This service was very well received by growers and was thought to be of value.

CONCLUSIONS & RECOMMENDATIONS:

Although this service was very worthwhile and appreciated by potato producers, it troubles the author that it was at best only a partial indicator of potential field efficacy.

In the field, efficacy of a pesticide, apart from the resistance factor, depends primarily on temperature and coverage. Some pesticides, such as the synthetic pyrethroids are known to lose effectiveness at higher field temperatures.

Thorough coverage is also important; the insect must be exposed to the chemical either by direct contact, by contact with sprayed surfaces and by ingestion of leaves covered with spray material.

Improvements in the test as it relates to potential field efficacy could be achieved if the use of foliage dipped in the appropriate insecticide solution was incorporated in the procedure.

ACKNOWLEDGEMENT:

The author wishes to express his appreciation for the efforts and dedication of Donald MacDougal and Colleen Trevors who worked assiduously on this project.

Funding was provided by the Cooperation Agreement on Agri-Food Development.

LITERATURE CITED:

Draft paper titled: A Simple and Rapid Bioassay Method to Assess Pesticide Resistance in the Colorado Potato Beetle by R.T. Roush, P.Beckley, D.N. Ferro, C.W. Hoy and W.M. Tingey, Department of Entomology, Comstock Hall, 1992.

An On-Farm Insecticide Resistance Test Kit for Colorado Potato Beetle (Coleoptera:Chrysomelidae), B.A. Bishop and E. Grafius, American Potato Journal, Volume 68, 1991.

PESTICIDE EFFICACY TEST RESULTS - 1991

These are your pesticide efficacy test results:

We collected adult colorado potato beetles from your field and submitted them to the following procedure:

First, we placed them in mesh bags (10 beetles/bag)
Then, each bag was dipped in jars containing 5 different concentrations of the 15 chemicals listed below:

Concentration 0 = distilled water only
Concentration 1 = recommended field rate
Concentration 5 = 5 times the field rate
Concentration 10 = 10 times the field rate
Concentration 20 = 20 times the field rate

The handwritten numbers on the chart represent the number of beetles having died within 24 hours after the treatment.

A	CONC.	1 SEV	2 FUR	3 SUP	4 END	5 GUT	6 LOR	7 DI-SYS	8 MON	9 DIB	10 THIM	11 IMI	12 CYM	13 DEC	14 BEL	15 AMB
GROWER NAME L. HAYWARD	0	0	0	0	0	2	0	2	0	0	2	1	1	0	2	1
	1	3	8	5	6	5	3	1	2	9	5	3	10	10	10	8
DATE June 12	5	5	5	0	9	9	6	5	3	10	8	10	10	10	10	10
	10	7	8	1	9	10	9	7	9	10	9	10	10	10	10	10
	20	10	8	5	10	10	9	—	8	10	10	10	10	10	10	10

1. SEV = SEVIN XLR
2. FUR = FURADIN 480F
3. SUP = SUPRACIDE
4. END = ENDOSULFAN 400
5. GUT = GUTHION
6. LOR = LORSBAN
7. DI-SYS = DI-SYSTON
8. MON = MONITOR
9. DIB = BIBROM
10. THIM = THIMET 15G
11. IMI = IMIDAN
12. CYM = CYMBUSH
13. DEC = DECIS
14. BEL = BELMARK
15. AMB = AMBUSH

Disclaimer

Because conditions and procedures in our lab are different from those used by producers in the field, the NB Department of Agriculture makes no warranty or guarantee of any kind, expressed or implied, concerning the use or efficacy of these products under field conditions. No product endorsement is implied nor is discrimination intended.

When applying pesticides, use only recommended label rates.

PESTICIDE EFFICACY TEST RESULTS - 1991

These are your pesticide efficacy test results:

We collected adult colorado potato beetles from your field and submitted them to the following procedure:

First, we placed them in mesh bags (10 beetles/bag)
Then, each bag was dipped in jars containing 5 different concentrations of the 15 chemicals listed below:

Concentration 0 = distilled water only
Concentration 1 = recommended field rate
Concentration 5 = 5 times the field rate
Concentration 10 = 10 times the field rate
Concentration 20 = 20 times the field rate

The handwritten numbers on the chart represent the number of beetles having died within 24 hours after the treatment.

A	CONC.	1 SEV	2 FUR	3 SUP	4 END	5 GUT	6 LOR	7 DI-SYS	8 MON	9 DIB	10 THIM	11 IMI	12 CYM	13 DEC	14 BEL	15 AMB
GROWER NAME J. BANKS	0	1	1	0	2	0	1	1	1	4	0	0	1	0	1	0
	1	3	1	7	8	10	5	2	8	10	5	10	10	9	8	9
DATE June 18	5	3	3	9	10	10	8	8	8	10	9	9	10	10	10	10
	10	4	6	10	9	10	9	9	10	10	10	10	10	10	10	10
	20	10	10	10	10	10	10	—	10	10	10	10	10	10	10	10

1. SEV = SEVIN XLR
2. FUR = FURADIN 480F
3. SUP = SUPRACIDE
4. END = ENDOSULFAN 400
5. GUT = GUTHION
6. LOR = LORSBAN
7. DI-SYS = DI-SYSTON
8. MON = MONITOR
9. DIB = BIBROM
10. THIM = THIMET 15G
11. IMI = IMIDAN
12. CYM = CYMBUSH
13. DEC = DECIS
14. BEL = BELMARK
15. AMB = AMBUSH

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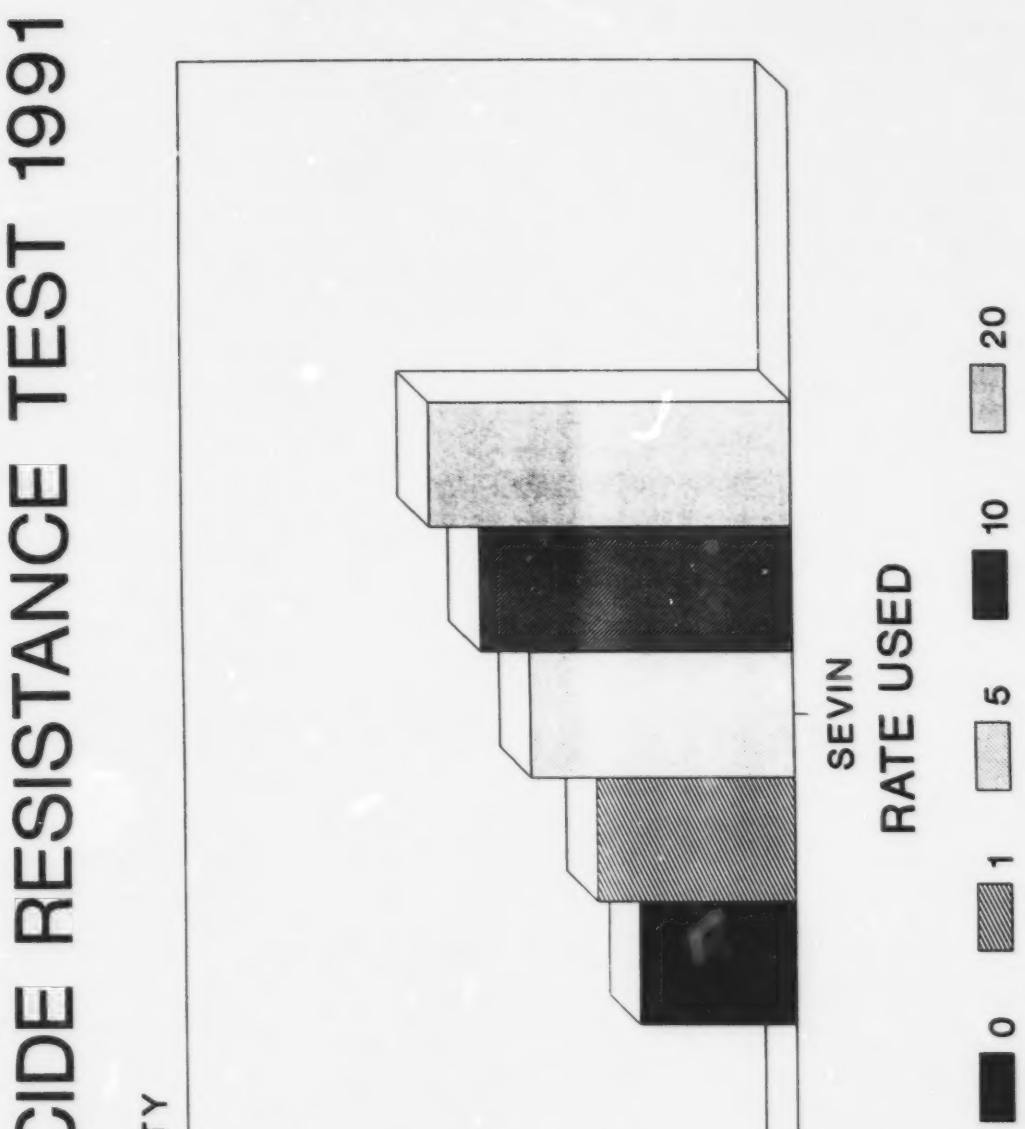
APPENDIX 3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9
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3
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SEVIN
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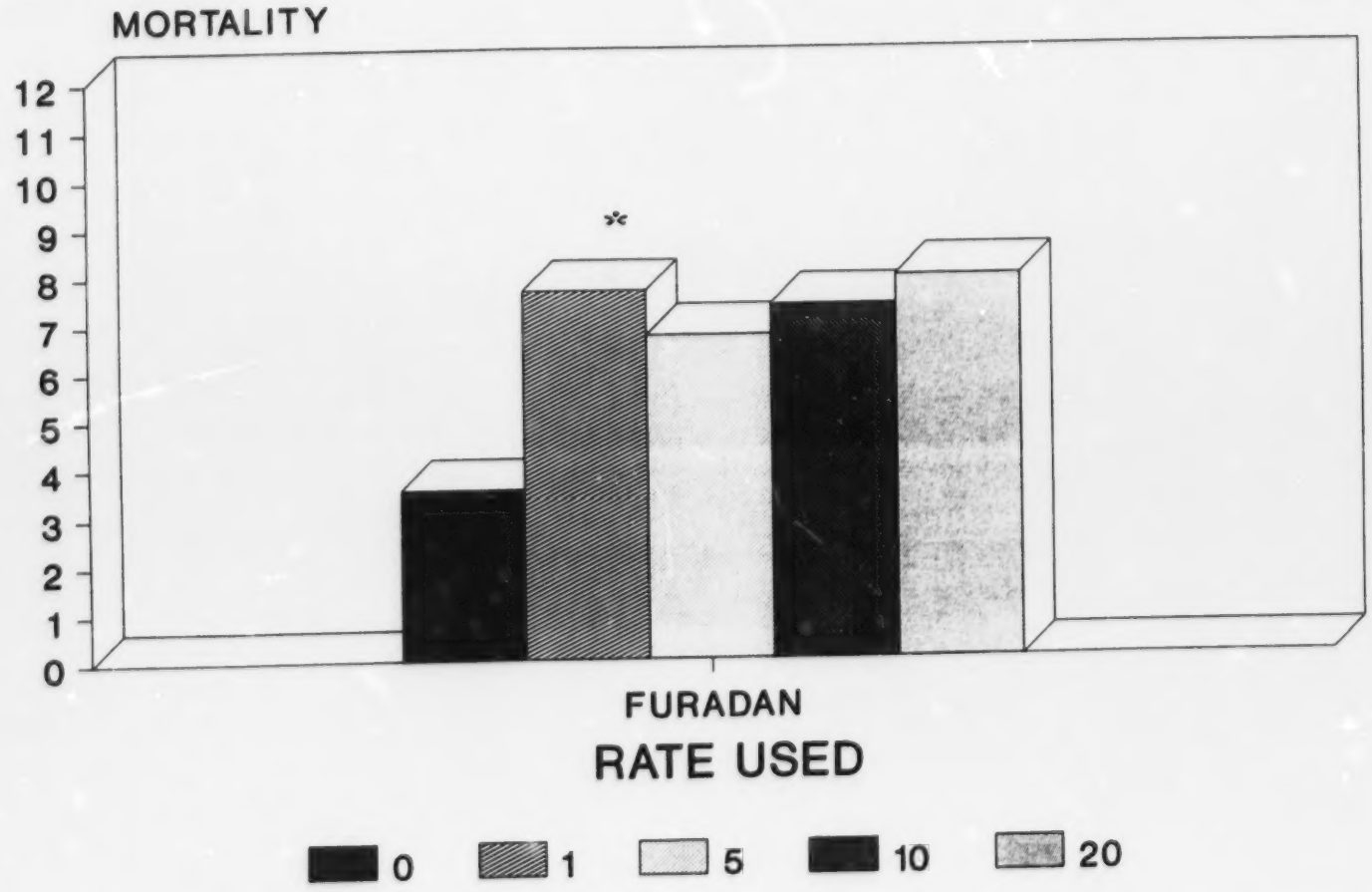
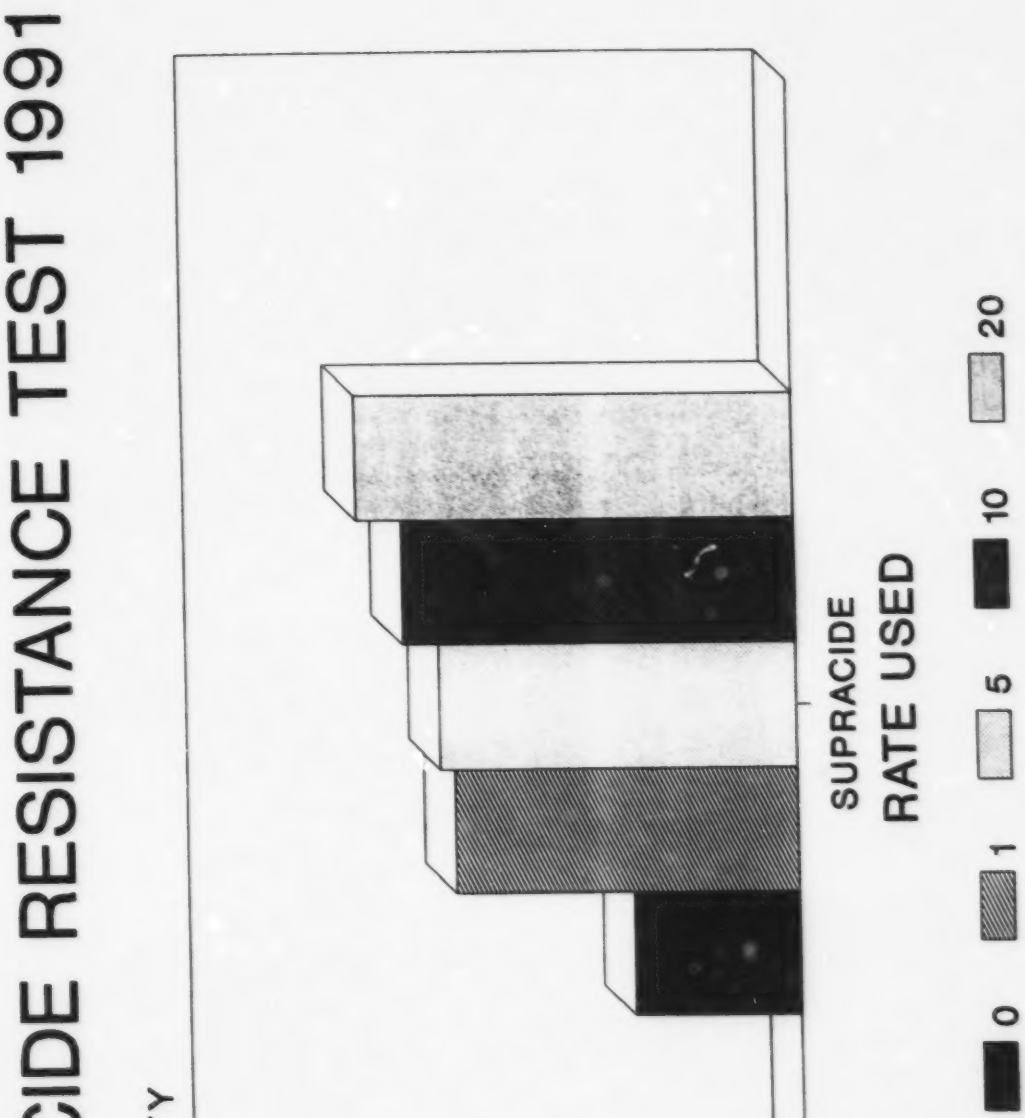
1
5
10
20

PESTICIDE RESISTANCE TEST 1991



* abnormal curve, error suspected; possibly due to unintentional switch in rate solutions; rate 1 appears to be rate 10.

APPENDIX 5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2
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SUPRACIDE
RATE USED
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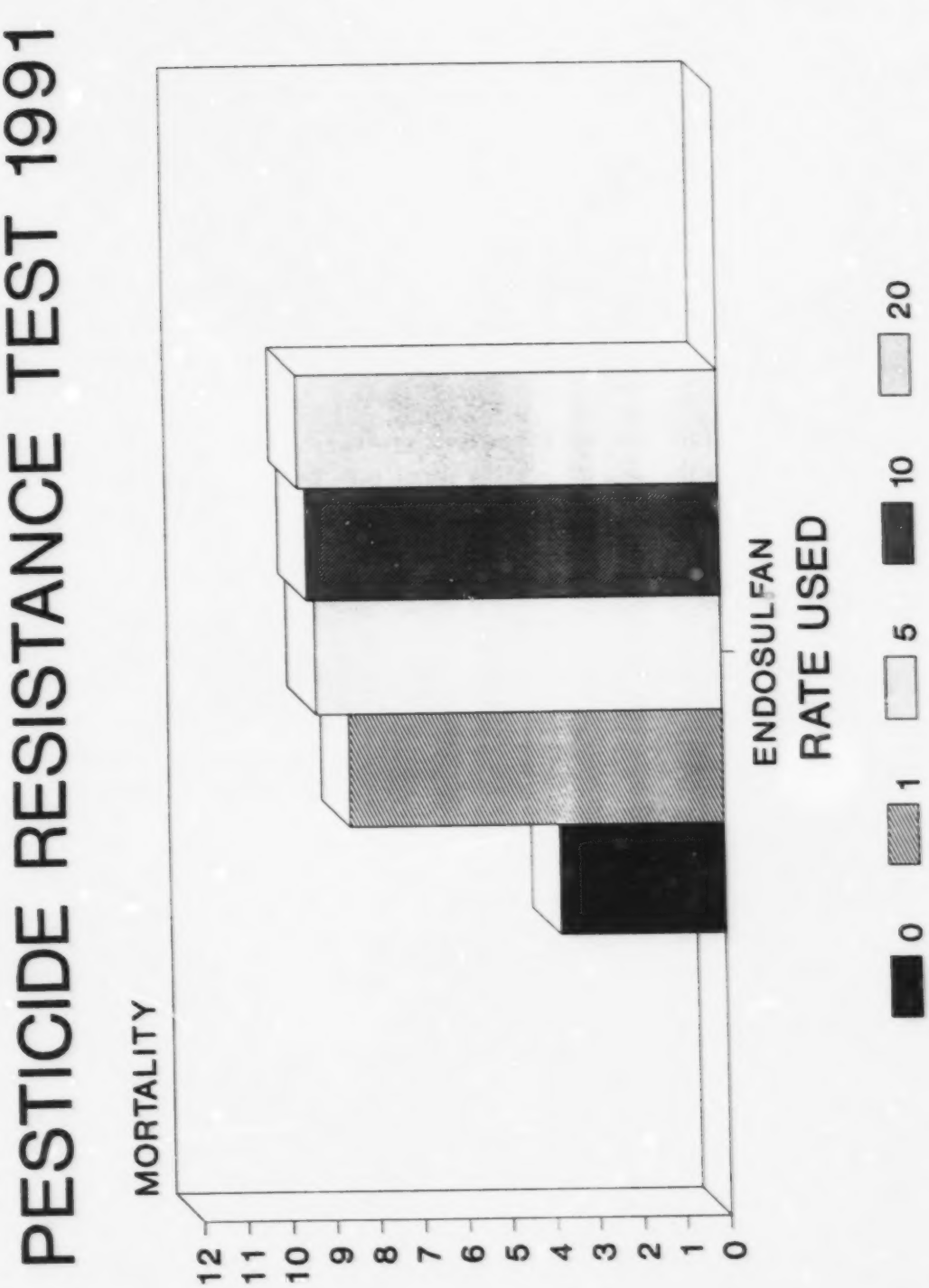
1
5
10
20

APPENDIX 6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8
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6
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ENDOSULFAN
RATE USED
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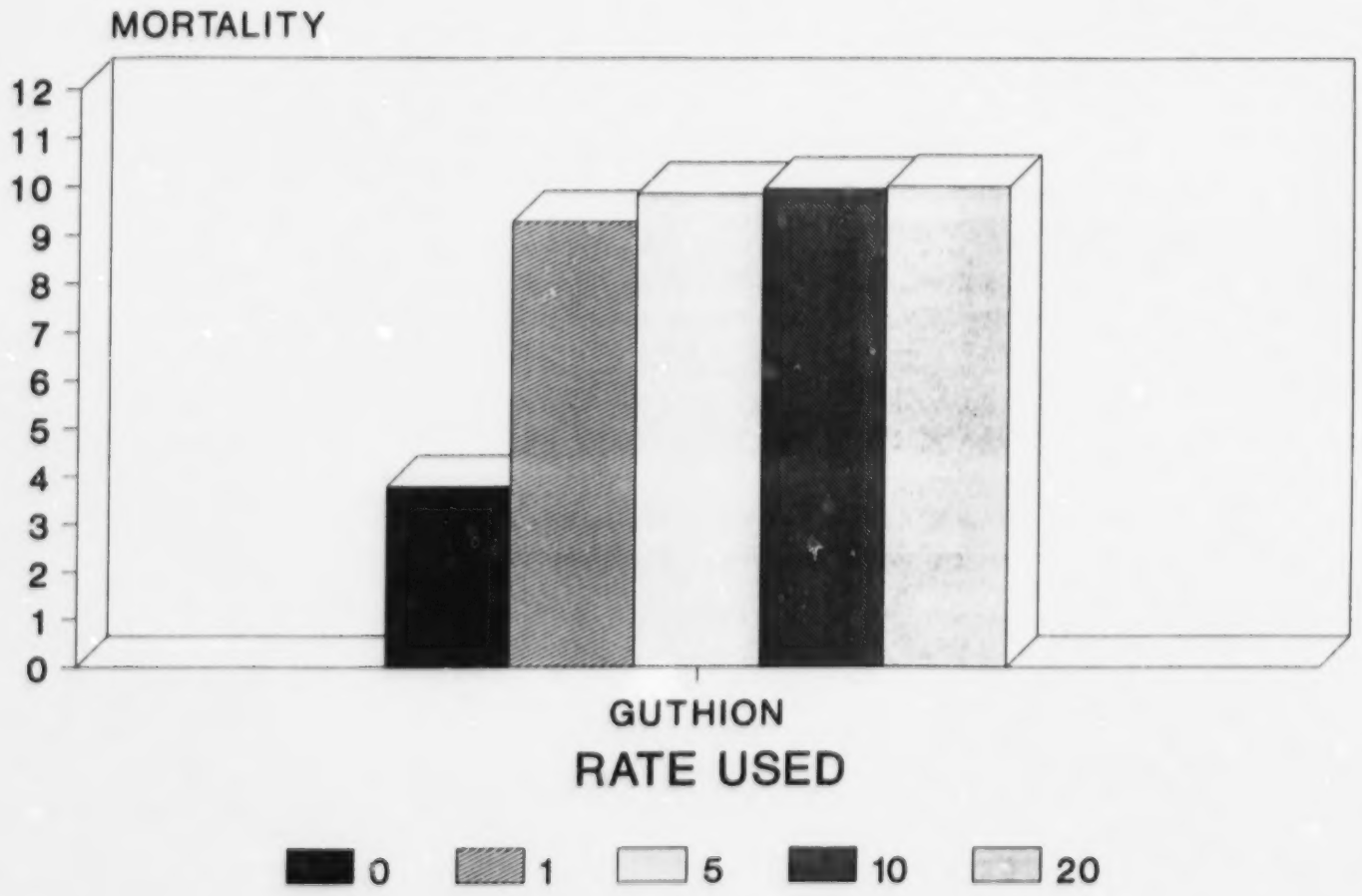
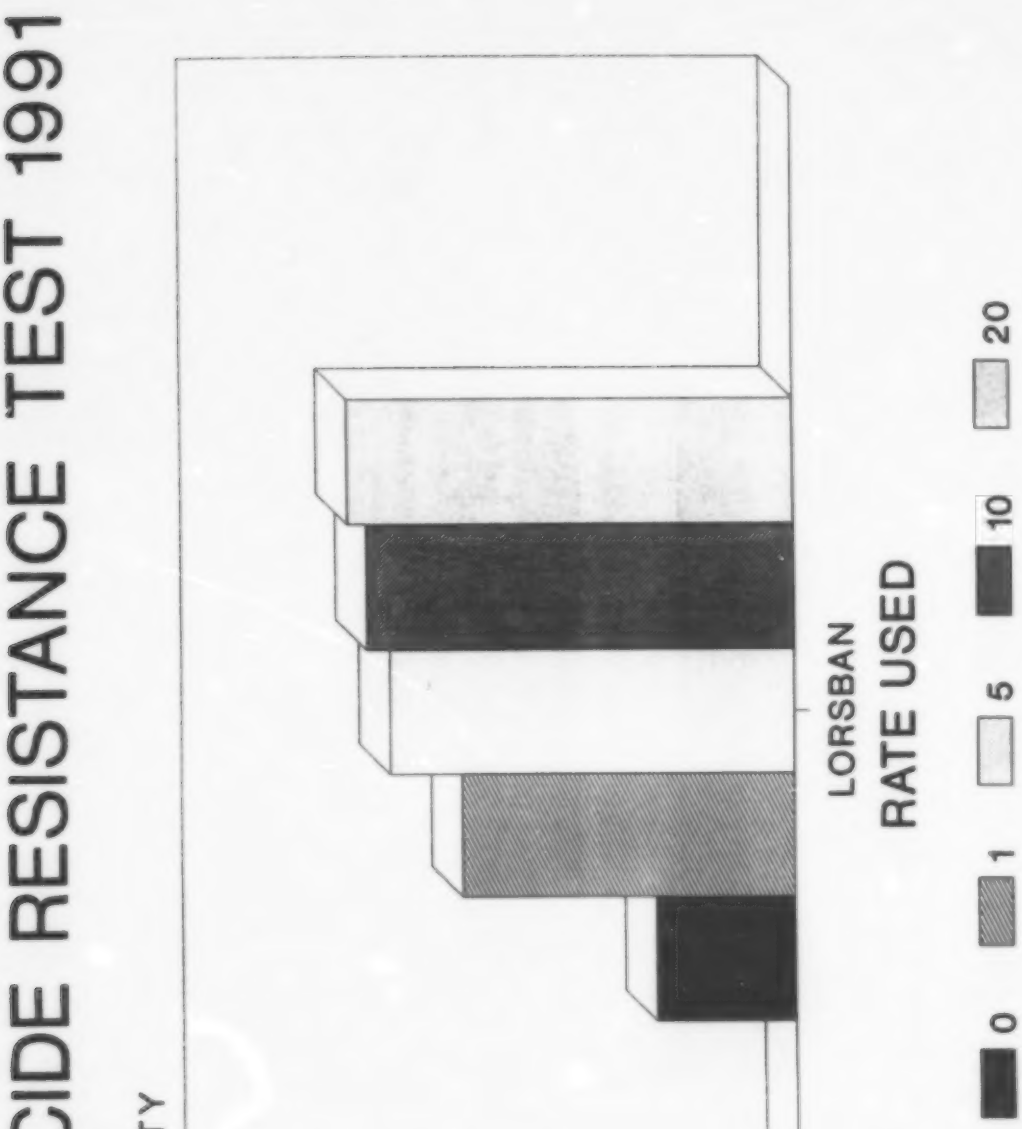
1
5
10
20

PESTICIDE RESISTANCE TEST 1991



APPENDIX 8


PESTICIDE RESISTANCE TEST 1991
MORTALITY
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10
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8
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4
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2
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LORSBAN
RATE USED
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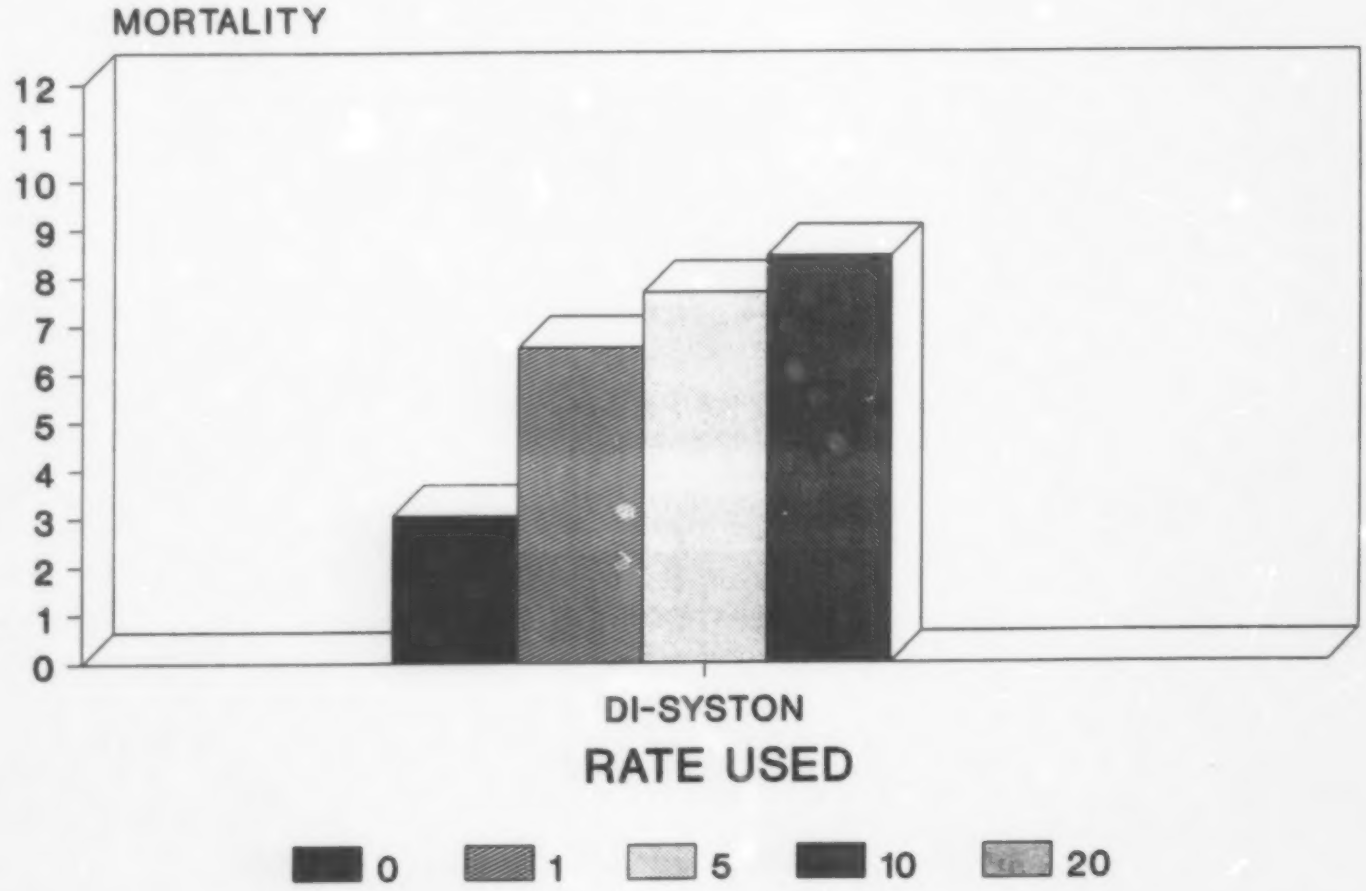
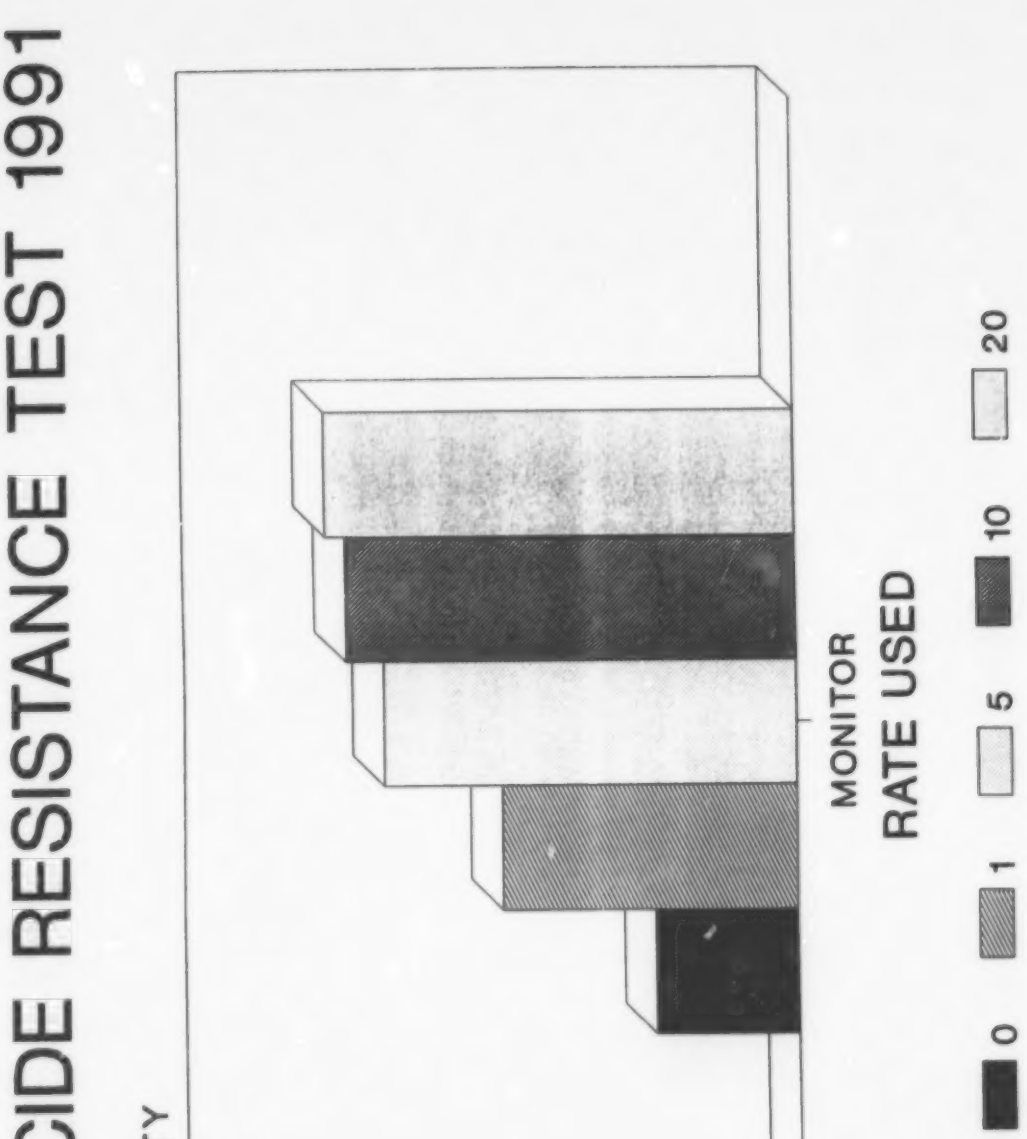
1
5
10
20

PESTICIDE RESISTANCE TEST 1991



APPENDIX 10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MONITOR
RATE USED
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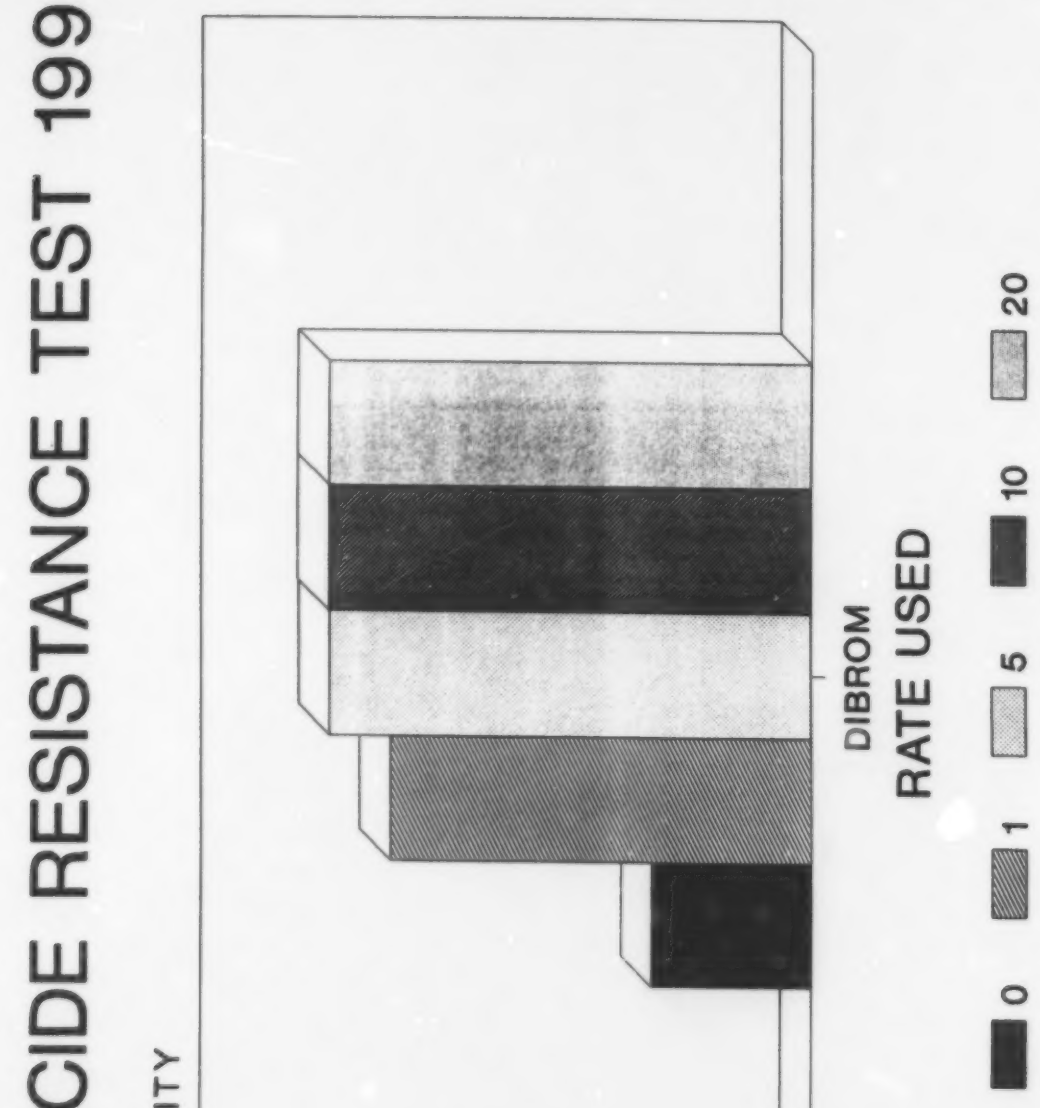
APPENDIX 11


PESTICIDE RESISTANCE TEST 1991
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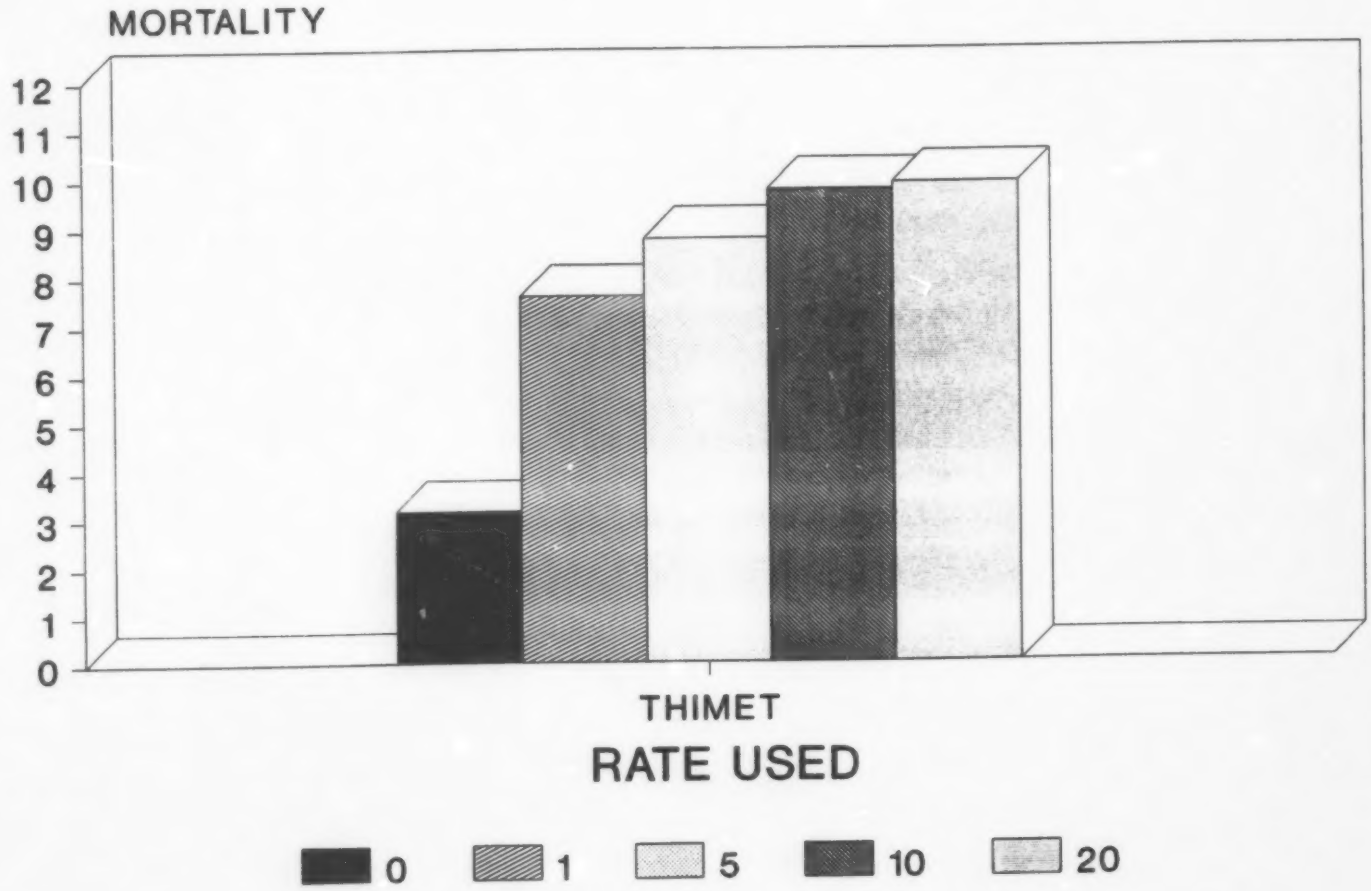
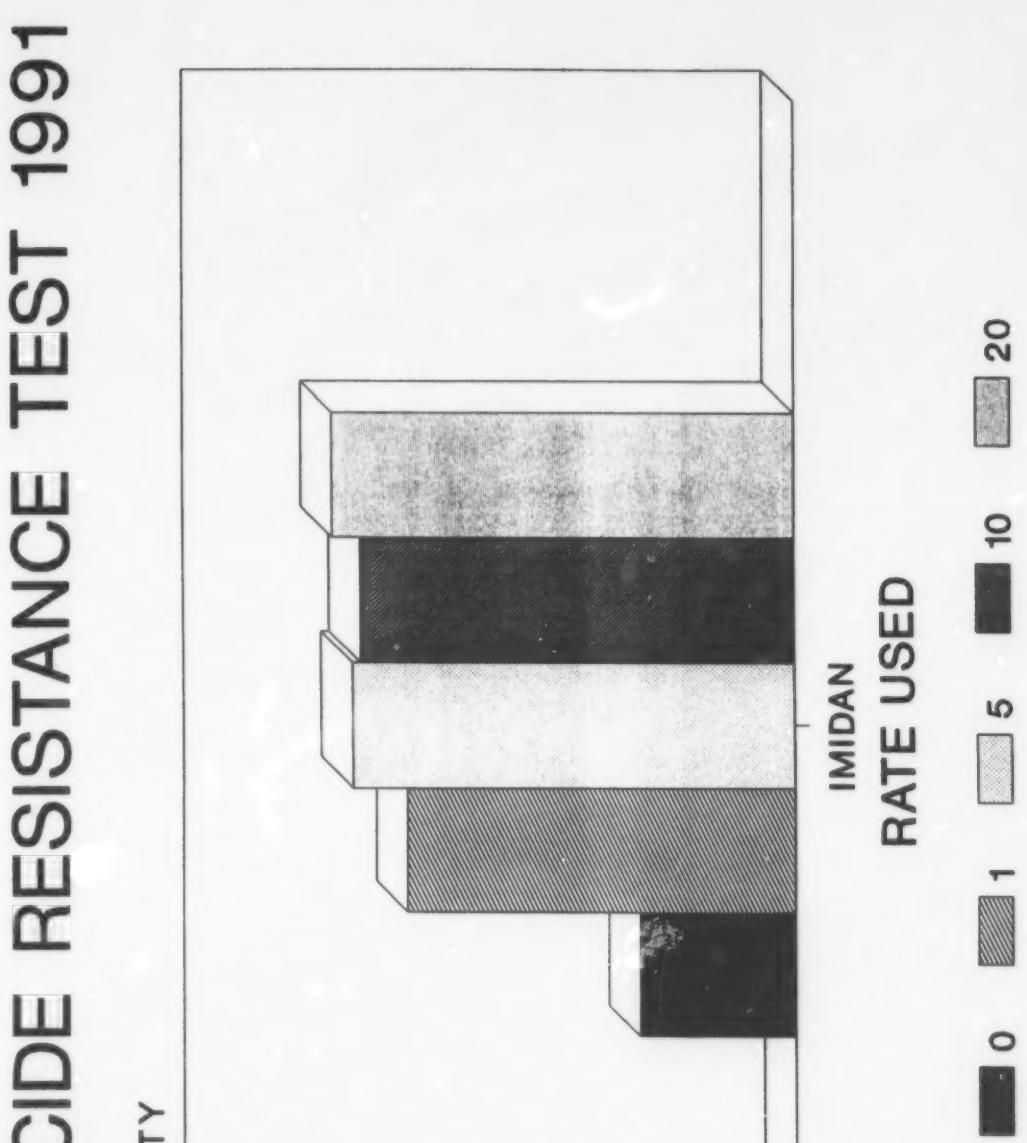
2
1
0
DIBROM
RATE USED
0
1
5
10
20

PESTICIDE RESISTANCE TEST 1991



APPENDIX 13


PESTICIDE RESISTANCE TEST 1991
MORTALITY
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10
9
8
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IMIDAN
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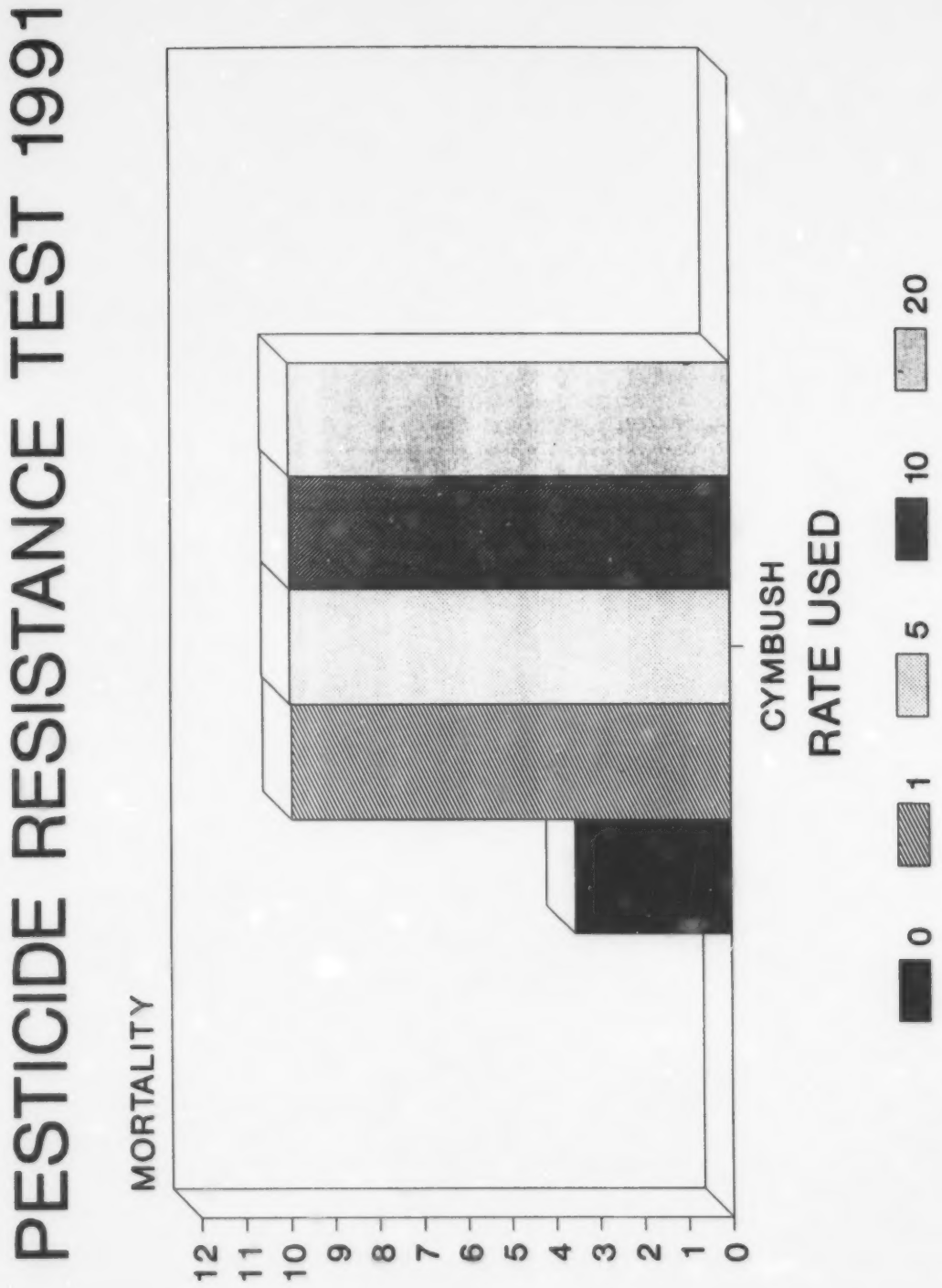
APPENDIX 14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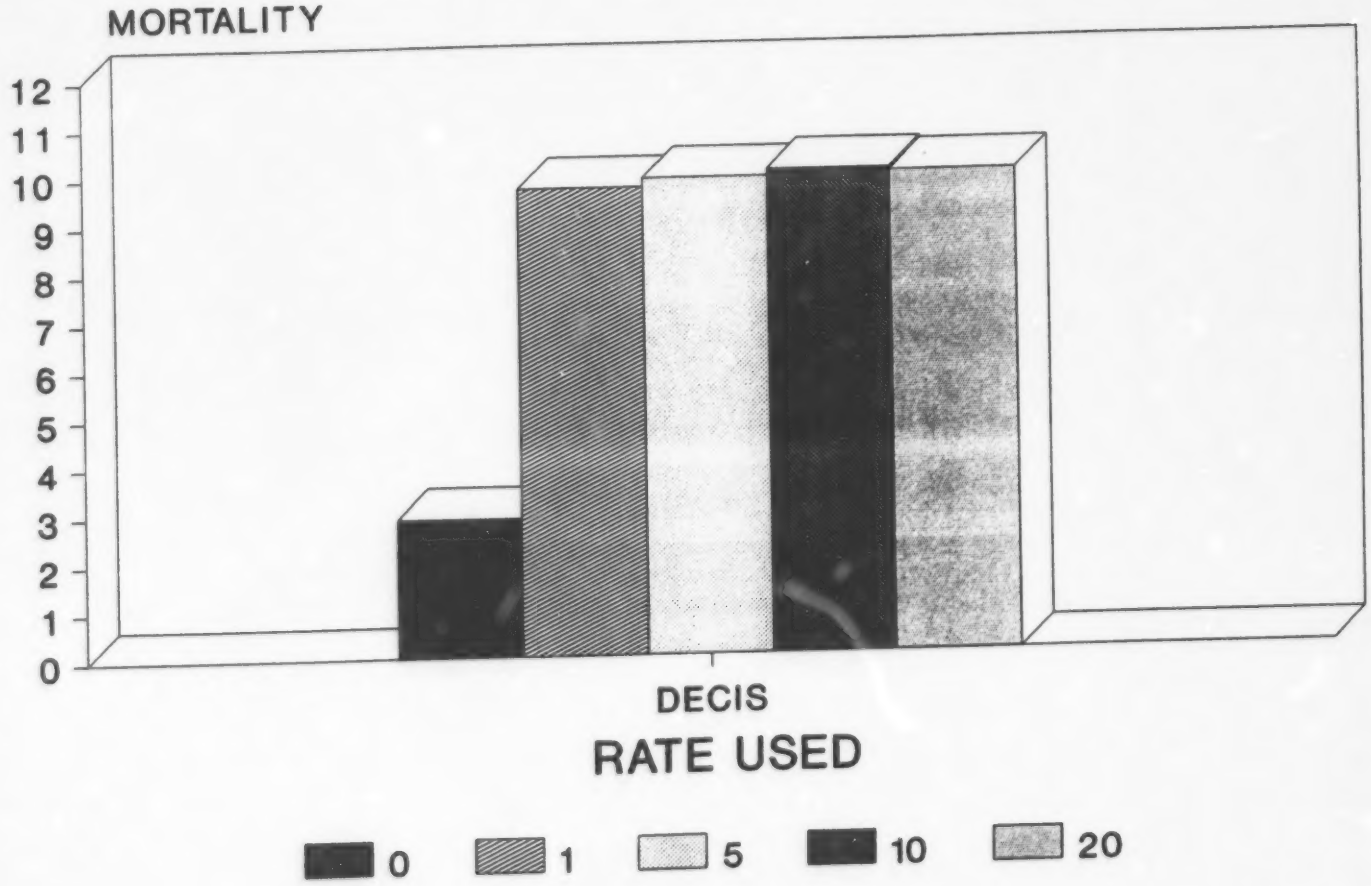
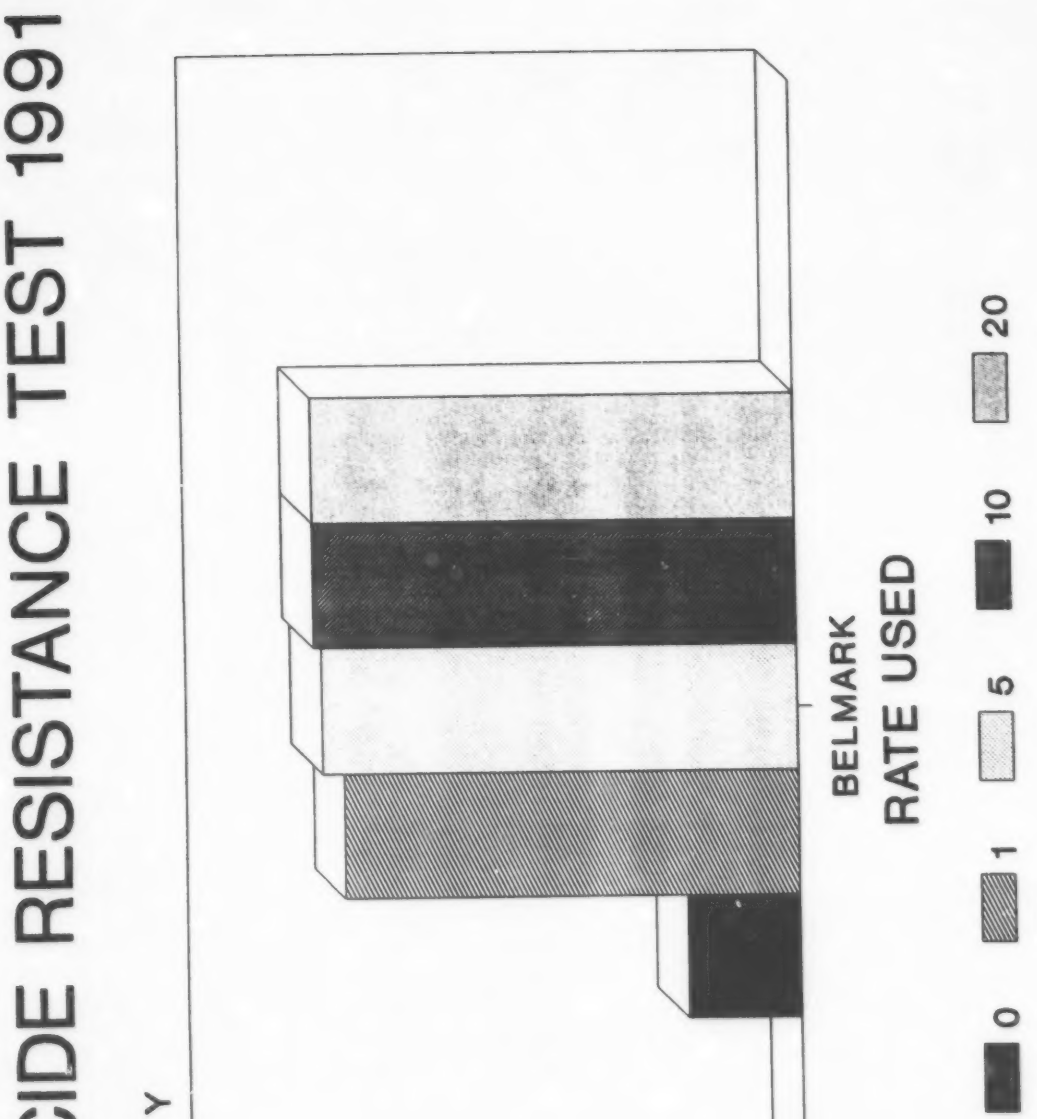
PESTICIDE RESISTANCE TEST 1991



APPENDIX 16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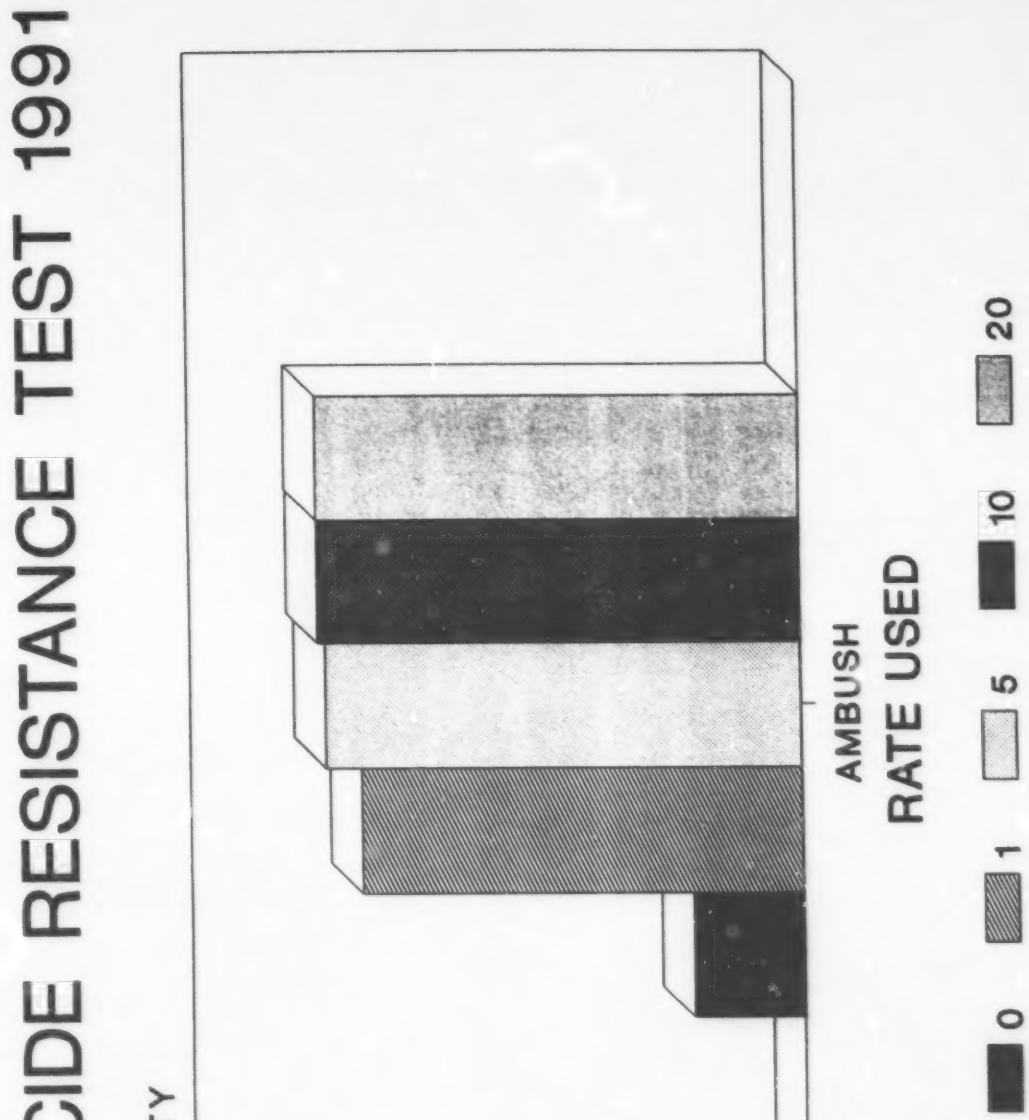
APPENDIX 17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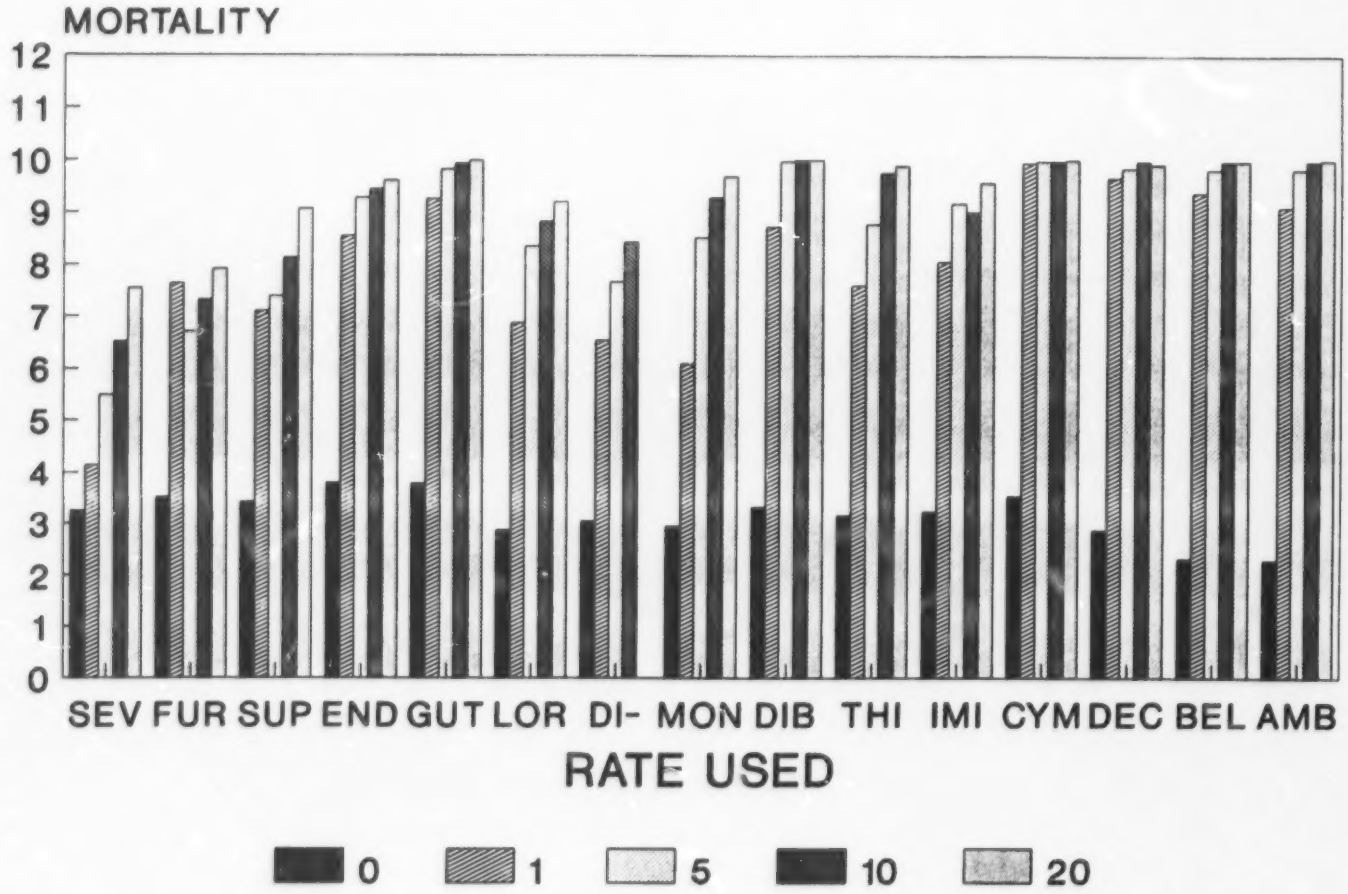

DEMONSTRATION OF THE EFFECTS OF BEST MANAGEMENT PRACTICES ON WATER QUALITY A PRELIMINARY REPORT

ÉVALUATION DE L'IMPACT DES MODES DE GESTION SUR LA QUALITÉ DE L'EAU RAPPORT PRÉLIMINAIRE

Clair Gartley[1], Paul Milburn[2] and John Richards[3]

ABSTRACT: A facility has been established on a potato farm in the Florenceville, NB area to demonstrate and evaluate the effects of agricultural production and conservation practices on water quality. The facility consists of a water monitoring building that collects surface and subsurface outflow from two terraced and systematically tiled potato fields. Measurement of flow volumes and associated sampling began January, 1992, and will continue for at least 10 years while various practices are compared and evaluated.

RÉSUMÉ: Un site d'études a été établi sur une ferme de pommes de terre dans la région de Florenceville au Nouveau-Brunswick afin d'évaluer et de démontrer les effets de la production agricole et des mesures de conservation sur la qualité de l'eau. Le site comprend une structure permettant la collecte de données sur l'écoulement des eaux de surface ainsi que des eaux souterraines provenant de deux champs de pommes de terre en terrasse et à drainage systématique. La collection de données sur les volumes d'écoulement et les échantillonnages associés ont débuté en janvier 1992 et continueront pour une période d'au moins dix ans pour assurer une évaluation adéquate de diverses pratiques culturales.

INTRODUCTION:

Proper control of agricultural chemicals is both an economic and an environmental necessity for sustainable farming systems. Financial loss is incurred when chemicals are "lost" or leached from the root zone due to inefficient use of high energy inputs; moreover negative environmental impacts may be incurred which impart an unfavourable image of the agricultural industry, and which could become injurious to public health if left unchecked.

Much of the current concern about agriculture and groundwater is coming from an environmental point-of-view. In the past several years, individual US state legislatures have been passing legislation on the issue (Solutions, 1988). For example, California's 1985 Pesticide Contamination Prevention Act requires that when an agricultural chemical is detected in groundwater, its registration must be cancelled unless the registrant can demonstrate that there is no health risk or that cancellation will cause severe economic hardship due to a lack of available alternatives. In Iowa, farmers are required to pay a user fee of 75 cents per ton on nitrogen fertilizers, and herbicide registration fees were increased to help finance education, research and demonstration projects under the 1987 Groundwater Protection Act. Maine, Wisconsin, Nebraska, Arizona and Florida have also passed groundwater related legislation.

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The Canadian agricultural chemical industry has formed an organization called the Crop Protection Institute of Canada which has published a 12 page pamphlet "Water in Trust" to advise growers about proper soil and chemical management practices. The Province of Ontario has begun a program called "Food Systems 2000" to assist growers to cut their use of pesticides by 50% over the next 15 years. Quebec has passed legislation (somewhat similar to Maine's) requiring growers to have training and registration prior to applying certain pesticides.

There is also a great deal of public concern in New Brunswick about groundwater contamination by agriculture (Telegraph-Journal, 1988). A sampling of approximately 45 private, domestic wells in the NB Potato Belt (Richards, et. al., 1989) found that average nitrate levels were greater in intensive potato growing areas than in non-potato areas and that nitrate levels in 8 wells were above the Canadian Drinking Water Standard of 10 ppm. (Canadian Water Quality Guidelines, 1987). A recent inventory of municipal groundwater supply areas in NB found 23 potato fields located within 81 well "protection" areas (Environment Canada, 1988).

During 1987-88, a joint study by Agriculture Canada, NBDA, and Environment Canada was conducted to determine if potato production practices commonly used in New Brunswick were potentially degrading groundwater sources and/or surface streams. The subsurface movement of agricultural chemicals was studied by measuring and sampling the discharge from systematic subsurface drainage systems installed in 5 potato fields. Three of the fields were "established potato rotation sites" and two of the fields were "non-potato rotation sites".

The soils were gravelly loam, loam, and clay loam soils commonly used for potato production. The organic matter content was 3.3 - 5.0% in the top 15 cm of soil. Concerning nitrate, the study found that (Milburn and Gartley, 1989 and Milburn, et. al., 1990):

1) Flow weighted average annual nitrate concentrations of the drain effluent equalled or exceeded 10 ppm for all potato site-years, regardless of antecedent crop rotation.

2) For the established potato sites, the flow weighted average annual nitrate concentration remained greater than 10 mg l^{-1} for the subsequent non-potato year.

3) Measured annual nitrate leaching losses ranged from 5 to 33 kg ha^{-1} for the potato-site years. Because drain outflow was not measured during winter and early spring flow events, these losses are conservative estimates of actual losses.

4) For the sites that did not have a history of potato production, the flow weighted average annual nitrate concentration of the drain effluent rose to approximately 10 mg l^{-1} the first year that they were planted to potatoes. Site background values prior to or following potatoes average 3 mg l^{-1}.

5) Following from items (1) to (4), it is likely that substantial nitrate leaching losses are occurring throughout the New Brunswick potato belt.

6) Within specific drain flow events, nitrate concentrations of the drain effluent varied by 100% or more. Depending on the time of flow events in relation to the date of fertilizer application, nitrate concentrations either increased or decreased as drain flow rate increased.

This study also involved the analysis of water samples for the pesticides dinoseb and metribuzin after their application to any of the potato field sites. A total of 232 tile discharge pesticide samples were collected between April, 1987 and April, 1989. On nineteen occasions, the concentration of dinoseb emanating from the tiles was observed in excess of the maximum acceptable toxic concentration of 0.5 ug/1 proposed by Woodward (1976) (O'Neill, et. al., 1989). But, 95% of the positive dinoseb and metribuzin samples (> minimum detection level) had concentrations less than 2 ppb. Dinoseb concentrations were less than detection level 18 months after application. Metribuzin concentrations ranged from 0.06 to 1.53 ppb. The average metribuzin concentration in tile outflow ten months after application was 0.22 ppb or 0.28% of the maximum acceptable concentration for drinking water. (Milburn, et. al., 1991).

Water quality research sites have been established by Agriculture Canada at the Charlottetown and Fredericton Research Stations. Also, a research and demonstration facility has been established by the Atlantic Land Improvement Contractors Association at Cornhill, NB (Milburn, et. al., 1989). The Research Station sites are concerned with potato and potato-rotation crops. The Cornhill site is being used to monitor corn and alfalfa crop production effects on groundwater quality (Milburn and Richards, 1991). All three sites are equipped with year-round monitoring systems since most tile discharge occurs during the winter months.

BMP DEMONSTRATION FACILITY ESTABLISHMENT:

The objectives of the Best Management Practices (BMP) Demonstration are to:

1) Establish a field scale soil and water conservation demonstration site in the NB Potato Belt.
2) Monitor the effects of common potato and rotation crop production practices on the quality of water draining from agricultural land.
3) Demonstrate and evaluate at field-scale, on-farm results of research conducted in the Atlantic Region and elsewhere that suggests crop, soil and/or water management practices that will sustain/improve the quality of water draining from agricultural land and result in more efficient crop management practices.

A number of possible sites for the BMP Demonstration Facility were investigated. A site on Stephenson's Farm Ltd., Connell (West Florenceville), NB, was chosen due to the following:

- The site was a large sloping potato field that had recently been terraced (1988) and systematically tiled (1990).
- The terrace and tile outlets could be brought together at the bottom of the field at a suitable location close to a public road and electrical power. Also, the outlets could be split to allow monitoring of two field areas (see Table 1).
- The owner agreed to allow access to the site and potato field for water and crop monitoring for a period of ten years.

Construction of an 8m x 8m insulated/heated monitoring building was completed in the Fall, 1991. Connector surface and subsurface drainage pipes were installed following building construction. The building has a large sump connected to an outlet pipe along one side. The surface and subsurface pipes enter from the opposite side under the floor and then flow into 4 Parshall flumes. Each flume is sized to measure at least the 25 year flow expected from the monitored field areas. Four automatic wastewater samplers are used to obtain samples from the inlet of each flume. Each sampler can be programmed to take 24 samples over minutes, hours, days or weeks. Flow measurement and sampling can occur throughout the year; the total volume of surface and subsurface drainage water leaving each field area can be measured.

The two field areas can be used to compare various practices. For example, the effects of a split fertilizer application versus regular application on water quality could be measured. Also, various producer, student and other groups are welcome to visit the facility to see first-hand agriculture's commitment to the environment.

TABLE 1 - MONITORED FIELD AREAS					
FIELD	OUTLET	TYPE	DRAINAGE AREA (ha.)	FARMED AREA (ha.)	PARSHALL FLUME WIDTH (mm)
1	1A	Subsurface	2.38	2.13	25
	1B	Surface	2.38	2.13	300
2	2A	Subsurface	6.95	6.10	75
	2B	Surface	6.95	6.10	750

PRELIMINARY RESULTS (as of February 1, 1992):

Both of the monitored field areas were planted to potatoes in 1990 and feed grain (barley) in 1991. The grain was sown May 28, 1991, following broadcast of 125 Kg/ha 15-15-15. 100 Kg/ha. of ammonium nitrate was applied June 15, 1991.

Given that the sampling and water discharge measurement equipment was installed late in 1991, only samples from several January thaws are available. Flume discharge measurements for January, 1992, are shown in Appendix I. Nitrate (NO_3-N) concentrations were less than 4 ppm in the surface and subsurface discharge samples; peak flows were less than 2 mm/day for the subsurface outlets and reached over 100 mm/day for the surface outlets. The peak discharge for the surface outlet from Field 1 reached .029 m^3/sec. and from Field 2 reached .066 m^3/sec.

The monitoring facility functioned well during this small event and allowed for a test of all equipment prior to spring runoff.

FUTURE PLANS:

Both field areas will be planted to potatoes in 1992. Similar practices will be used on each field to calibrate the monitoring facility. Complete 1992 flow results and water quality measurements will be found in future reports.

ACKNOWLEDGEMENTS:

The authors wish to acknowledge the assistance and co-operation of Stephenson Farms Ltd.; Bruce Kinnie, Rod MacIntosh, Ken Brewer and Mo Colwell of NBDA; and Rick Allaby and Garnett DeMerchant of the Fredericton Research Station.

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BEST MANAGEMENT PROJECT
FLORENCEVILLE, NB
DISCHARGE (mm/day)
JULIAN DATE 1992
0 10 20 30 40 50
— PLOT 1A,SUBSURFACE

BEST MANAGEMENT PROJECT
FLORENCEVILLE, NB
DISCHARGE (mm/day)
JULIAN DATE 1992
0 10 20 30 40 50
— PLOT 1B,SURFACE

BEST MANAGEMENT PROJECT
FLORENCEVILLE, NB
DISCHARGE (mm/day)
JULIAN DATE 1992
0 10 20 30 40 50 60
— PLOT 2B,SURFACE

BEST MANAGEMENT PROJECT
FLORENCEVILLE, NB
DISCHARGE (mm/day)
JULIAN DATE 1992
0 .5 1 1.5 2
0 20 30 40 50
— PLOT 2A,SUBSURFACE

APPENDIX 1

POTATO STORAGE SURVEY SUMMARY

SOMMAIRE DE L'ÉTUDE SUR L'ENTREPOSAGE DES POMMES DE TERRE

Walter Allison, Ken Brewer and Bruce Kinnie

ABSTRACT:

During the summer of 1990, a comprehensive survey of New Brunswick's potato storages was undertaken by the engineering staff of the Potato and Agricultural Resource Centre, Wicklow, New Brunswick. Funding for the project was supplied through the Cooperation Agreement on Agri-Food Development. Four students were employed to physically measure and assess each storage. Collected information was entered into a dBase IV database to facilitate updating on a annual basis.

RÉSUMÉ:

Au cours de l'été 1990, l'équipe d'ingénieurs du Centre de ressources agricoles et de la pomme de terre de Wicklow, au Nouveau-Brunswick, a mené une vaste étude portant sur les entrepôts de pommes de terre de la province. Ce projet a été financé grâce à l'Entente de coopération Canada/Nouveau-Brunswick sur le développement du secteur agro-alimentaire. Quatre étudiants ont été chargés de mesurer et d'évaluer chaque entrepôt. L'information ainsi recueillie a été entrée dans la base de données dBase IV afin de faciliter la mise à jour annuelle de ces renseignements.

INTRODUCTION:

In March 1990 funding was requested, under the Cooperation Agreement on Agri-Food Development, to perform a complete survey of potato storage facilities in the province. The data obtained was collected to meet several specific objectives:

i) To assess present provincial storage capacity.

ii) To evaluate the condition of storages so that future public funding inputs will achieve maximum impact, whether in new construction or in renovation of existing structures.

iii) To predict future storage requirements, and present an agenda with associated costs for any replacement programme.

iv) To evaluate the province's ability to meet the demands of new markets.

v) To continue to focus the attention of growers on the importance of good storage and good storage management.

METHOD:

Four students were hired to visit every storage in the province, throughout the summer of 1990, and collect the required data. Information was collected on storage size, construction, insulation and condition, ventilation capacity, type and controller as well as the presence and type of humidification system. After collection, the data was entered into a microcomputer database (dBase IV) for data analysis. A perpetual inventory of potato storages may be maintained by entering storage construction, renovation and abandonment on a yearly basis.

RESULTS:

The following tables are based on the original data collected in 1990; the 1991 data has not yet been entered into the database.

In 1990 there were 648 potato storages and 103 extensions to storages in New Brunswick. In analysis of storage functionality, storage extensions were considered an integral part of their corresponding storages, giving a total of 648 storage units. In analysis of storage construction, extensions were treated as distinct structures, giving a total of 751 (648+103) storage structures.

Ventilation System	Storage		Capacity	
	#	%	CWT	%
Main Plenum & Delivery Duct	152	23.5	5 092 396	39.6
Individual Fan & Duct	129	19.9	2 548 746	19.8
Exhaust Fan	185	28.5	3 062 416	23.8
None	182	28.1	2 164 724	16.8
TOTAL:	**648**	**100.0**	**12 868 282**	**100.0**

Humidification System	Storage		Capacity	
	#	%	CWT	%
Pump & Nozzle	44	6.8	1 325 125	10.3
Air & Water	40	6.2	1 516 284	11.8
Disc	35	5.4	1 319 129	10.2
None	529	81.6	8 707 744	67.7
TOTAL:	**648**	**100.0**	**12 868 282**	**100.0**

Type of Controller	Storage		Capacity (CWT)%	
	#	%	CWT	%
Analog Panel	98	15.1	3 551 966	27.6
Computer	3	0.5	134 000	1.0
Thermostat	274	42.3	5 503 155	42.8
Manual	273	42.1	3 679 161	28.6
TOTAL:	**648**	**100.0**	**12 868 282**	**100.0**

Year Constructed	Structure		Capacity	
	#	%	CWT	%
Before 1961	235	31.3	2 840 473	22.1
Between 1961 & 1970	192	25.6	3 783 431	29.4
Between 1971 & 1980	194	25.8	3 116 175	24.2
Between 1981 & 1990	130	17.3	3 128 203	24.3
TOTAL:	**751**	**100.0**	**12 868 282**	**100.0**

County	Storage		Capacity	
	#	%	CWT	%
Carleton	265	39.5	6 072 610	47.2
Gloucester	13	2.0	147 874	1.1
Kent	4	0.6	39 212	0.3
Madawaska	93	14.4	1 868 509	14.5
Northumberland	3	0.5	32 109	0.2
Queens	1	0.2	1 069	0.0
Restigouche	13	2.0	191 268	1.5
Sunbury	2	0.3	18 600	0.1
Victoria	244	37.7	4 355 486	33.8
Westmorland	6	0.9	106 285	0.8
York	4	0.6	35 260	0.3
TOTAL:	**648**	**100.0**	**12 868 282**	**100.0**

Type of Structure	Structure		Capacity (CWT)%	
	#	%	CWT	%
Stud Wall	301	40.1	5 407 731	42.0
Concrete with Gambrel Roof	222	29.6	2 796 121	21.7
Steel Arch	83	11.0	2 440 105	19.0
Concrete with Gable Roof	76	10.1	1 266 591	9.8
Other (Steel, Wood Arch, Etc.)	69	9.2	957 734	7.4
TOTAL:	**751**	**100.0**	**12 868 282**	**100.0**

End Use of Product	Storage		Capacity (CWT)%	
	#	%	CWT	%
Seed	228	35.2	3 759 270	29.2
Tablestock	99	15.3	1 414 899	11.0
Processing	188	29.0	4 944 448	38.4
Seed & Tablestock	36	5.6	784 035	6.1
Seed & Processing	30	4.6	595 354	4.6
Tablestock & Processing	52	8.0	1 139 415	8.9
All or Unknown	15	2.3	231 861	1.8
TOTAL:	**648**	**100.0**	**12 868 282**	**100.0**

CONCLUSIONS:

It should be noted that 40.6 percent of the storage capacity in the province has no through-the-pile ventilation of even insufficient capacity. Lack of adequate ventilation may result in temperature differences throughout the pile, causing inconsistent aging and irregular colour. Difficulties could also arise from localized freezing or breakdown (as a result of disease or surface moisture). Through-the-pile ventilation permits the harvest of wetter potatoes that would otherwise be impossible to store. Adequate ventilation permits the drying of some surface moisture on potatoes in storage.

Only 32.3 percent of storage capacity is equipped with mechanical humidification. The 1982 Potato Storage Survey did not attempt to deal with humidification except for one type. It can be assumed that of the other types available, there were very few, if any, in

place at that time. At that time only 2 percent of the total storage capacity had a recognized humidification system. It has been stated that a humidified storage can save 4 percent on weight loss over an unhumidified storage during the normal storage season of 6 months. Lack of adequate humidification, unlike ventilation, does not make itself known by dramatic breakdown but is more insidious as the producer finds that he simply has less potatoes to sell.